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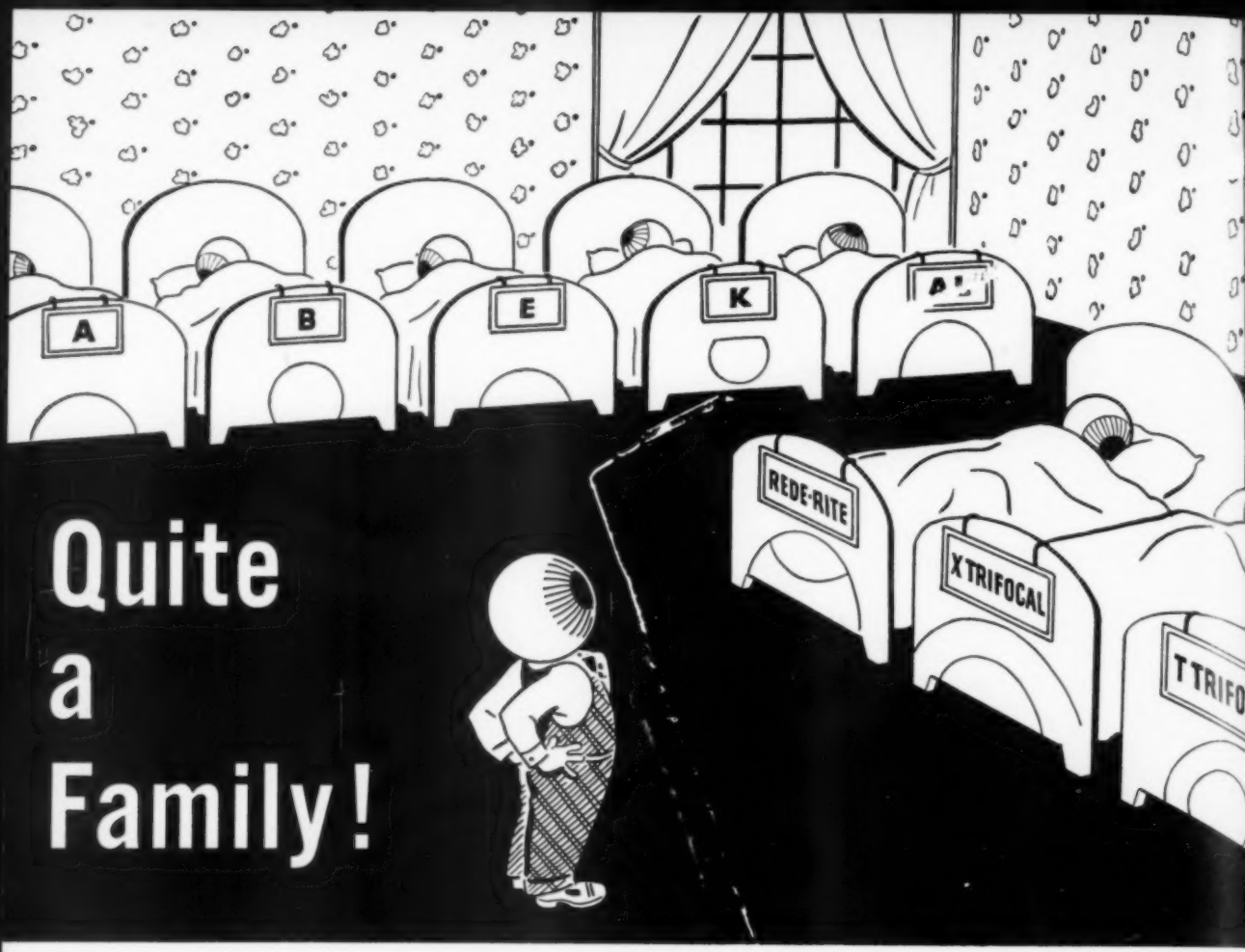

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1

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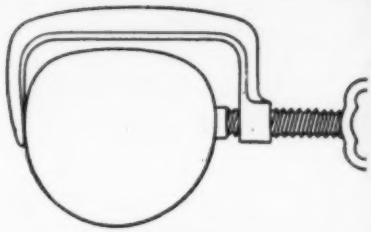

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2

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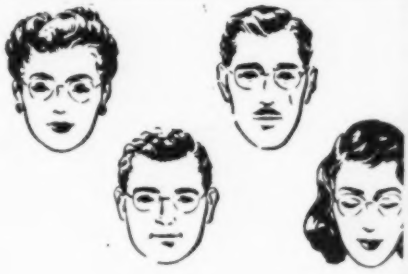
This new "strapless" construction is distinctive and attractive. It has instant appeal to style-minded patients . . . it is flattering to those people who want eyewear that is "different" without being extreme.



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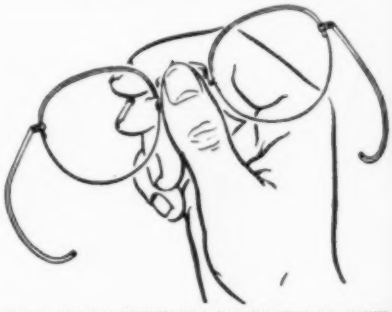

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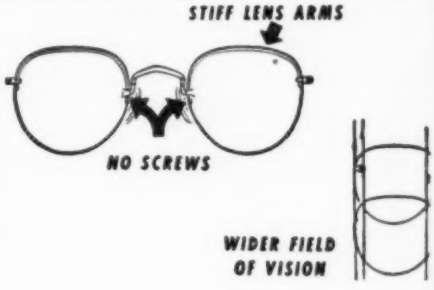

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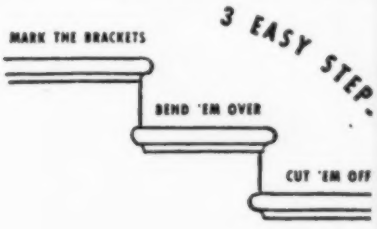

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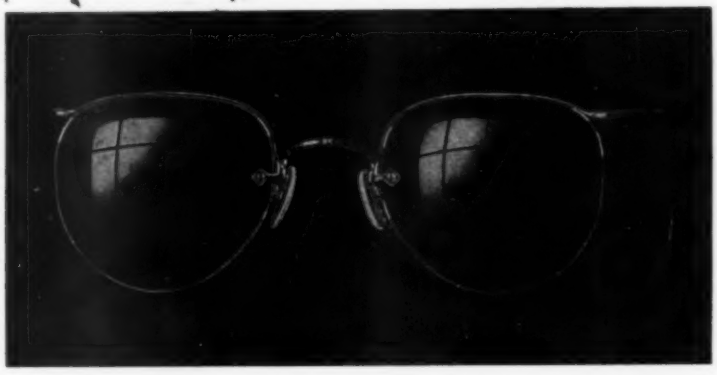

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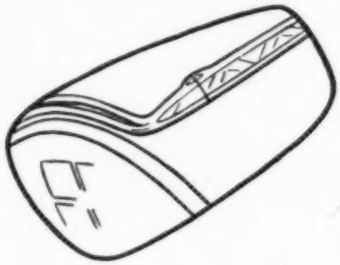

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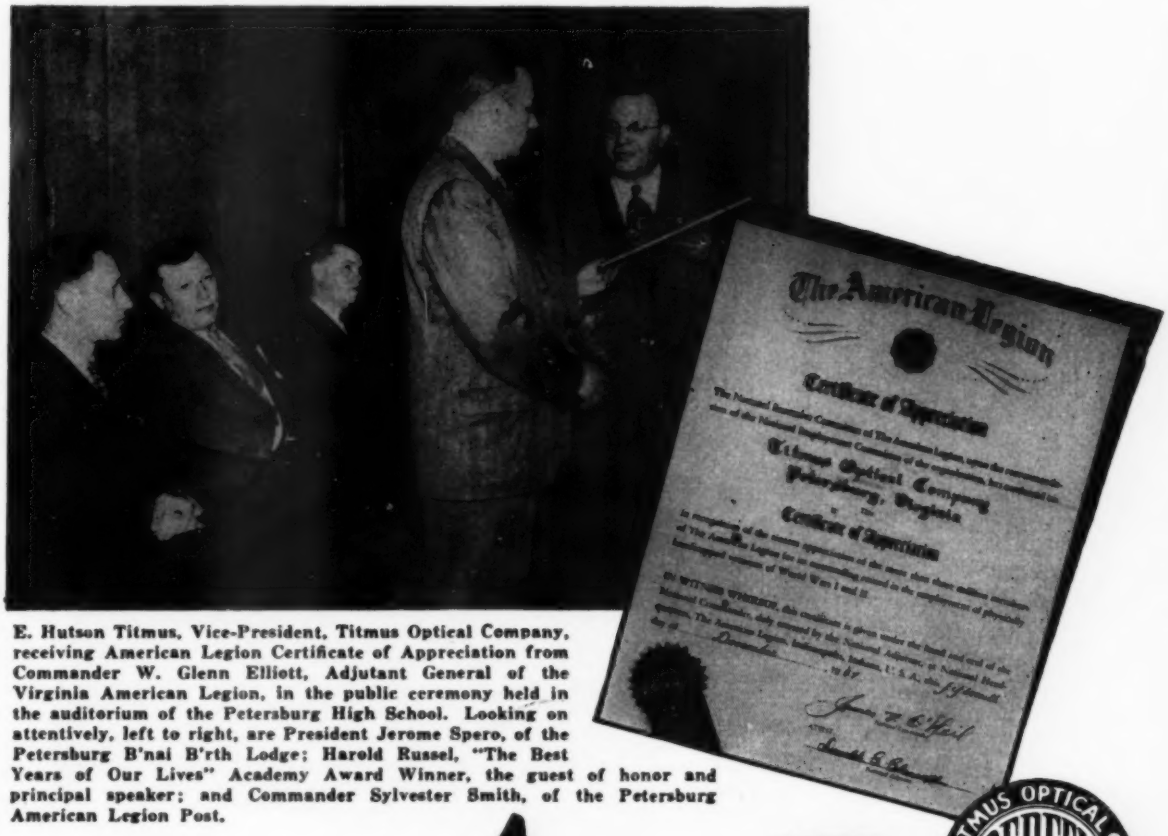

E. Hutson Titmus, Vice-President, Titmus Optical Company, receiving American Legion Certificate of Appreciation from Commander W. Glenn Elliott, Adjutant General of the Virginia American Legion, in the public ceremony held in the auditorium of the Petersburg High School. Looking on attentively, left to right, are President Jerome Spero, of the Petersburg B'nai B'rth Lodge; Harold Russel, "The Best Years of Our Lives" Academy Award Winner, the guest of honor and principal speaker; and Commander Sylvester Smith, of the Petersburg American Legion Post.

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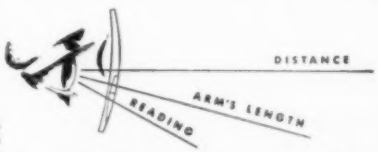
Patients with similar complaints are nothing new. When a presbyope requires a two-diopter addition, he does so because he has approximately one diopter of amplitude left, half of which he can exert comfortably in reading. The result is that while he can see clearly



through his distance correction and can read comfortably, this patient is surrounded at all times by an annoying zone of blur in the arm's length visual area. *(See cut)*

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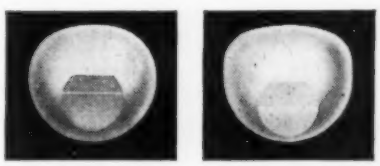

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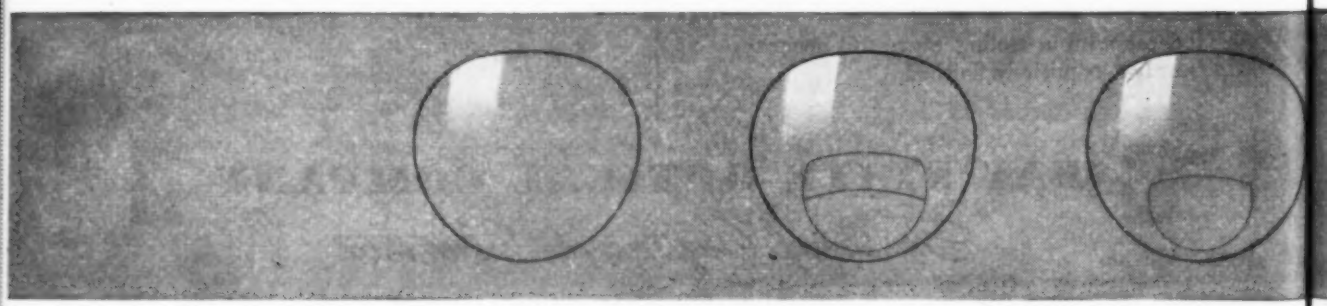

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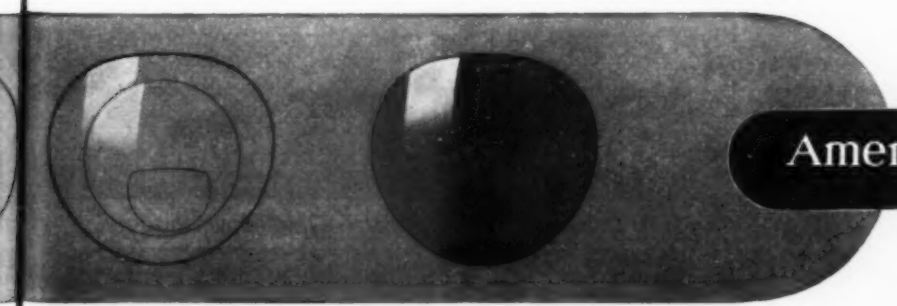

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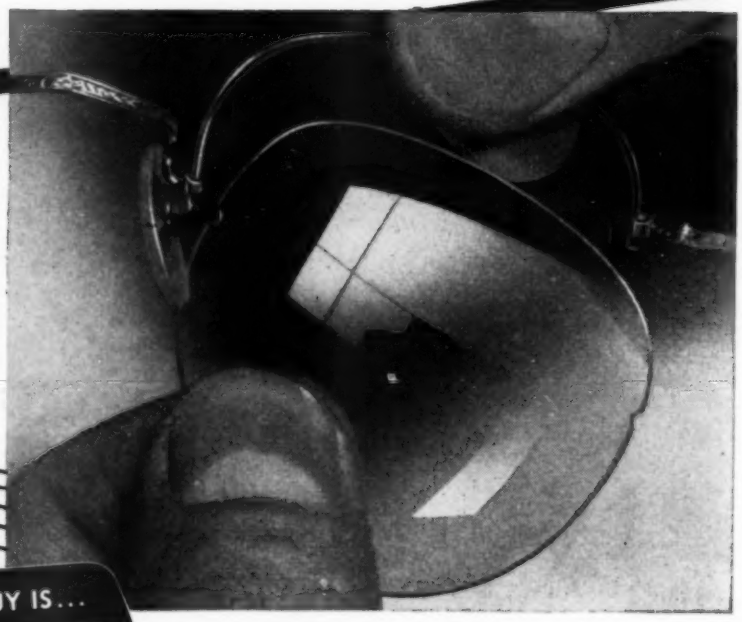

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Vol. 25 MARCH, 1948 No. 3

AN ANALYSIS OF VISUAL PERFORMANCE IN RELATION TO SAFETY*

Fred W. Jobe†
Rochester, New York

The problems in an eye clinic connected with an industry are in many ways exactly the same as those in a private practice. This is not surprising when it is considered that the purpose of a visual examination is to determine the proper method for obtaining and maintaining adequate visual performance for whatever visual task that needs to be performed. The task may be one of operating a machine for industrial production or it may be one of performing the duties of a housewife, playing golf or bridge, or any activity where vision is required.

An eye department in an industrial organization has many advantages as well as some disadvantages. In industry there is a wealth of information about the patient that may be obtained for examination. Records are available of production, accidents, earnings and many other factors that give a picture of the individual patient that is almost impossible to obtain from a patient in the office of a private practitioner. The same records enable the optometrist in industry to check on the results of his examination and treatment as they may affect the visual efficiency of the individual on his job.

Of course in industry, as in private practice, the optometrist receives patients that report to the eye clinic because of headaches, eye strain, "seeing" difficulties, or a combination of these and other factors. Discomfort is the factor that causes most patients to seek professional aid. It is obvious that as long as the general population is not vision conscious from the standpoint of visual efficiency the potential contributions that the ophthalmic professions can render have not been tapped.

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*Read before the Annual Meeting of the American Academy of Optometry, Philadelphia, Pennsylvania, May 21, 1947. For publication in the March, 1948, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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The professions and the industry have, perhaps unwittingly, built a fence around themselves that has served to limit their field of usefulness. Such mistaken conceptions as: "Eyes are either good or bad," "Eyes are normal or defective," "Vision is perfect or imperfect," or "Glasses are a correction of a defect," form artificial restrictions that limit the professional man's usefulness to the public. It is necessary to break down these restrictions and get across the idea of efficient and inefficient vision for the visual task. In this the eye clinics of industry can serve by analyzing the data obtained in the clinic in its relation to the various factors that are affected by degrees of visual efficiency.

One of the relationships that an industrial eye clinic has an opportunity to study is the one between vision and safety. It is such an analysis that this paper reports.

A preliminary investigation of this relationship was made by the Ortho-Rater department in conjunction with the safety department of the Bausch and Lomb Optical Company. In this study 42 persons having an accident frequency of three or more accidents in the previous 12 months were matched with another group of 42 accident free persons. The individuals in each group were paired for age, sex, education, occupation, and experience. The accident records were obtained from the hospital and included not only lost-time accidents but any accident

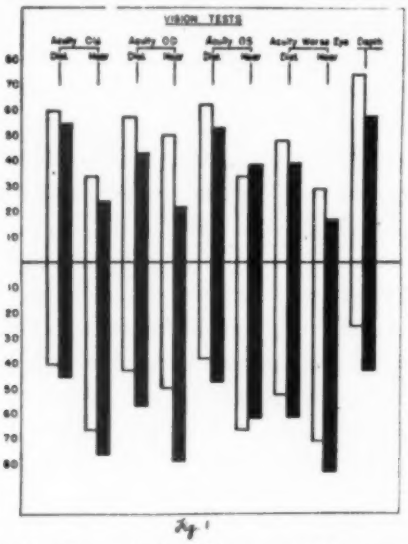


Fig. 1

that caused a visit to the hospital. Minor accidents such as burns, cuts, etc., were included. Major accidents were eliminated as they were mainly caused by outside factors. As far as possible, accidents were not count-

ed when there was a possibility that the accident was caused by others or by conditions that the subject could not have controlled. Visual performance was measured with the Ortho-Rater by trained testers.

The result of the study is shown graphically in Figure I. On this bar graph has been plotted the percentage in each group that passed or failed some of the individual tests. The tests for distance vision include: visual acuity for right eye, left eye and both eyes; and stereoscopic acuity. The tests for near vision include the same visual acuity tests but not a depth test. The lowest acuity obtained with either eye was recorded as "worse eye."

A passing score was 10 or better for visual acuity and five or better for depth acuity. These are arbitrary scores used on the Ortho-Rater. It has been shown by Davis[1] that an individual scoring 10 or more on the Ortho-Rater would score 20/25 or better in the eye clinic. This applies to one eye clinic with the examiners, equipment and conditions present in that clinic, and would vary somewhat from office to office.

A score of five or more on the depth test means that the individual can distinguish a stereo parallax of 27 seconds of arc, or on the Fry-Sheppard scale has a stereo acuity of 88.5 per cent. This score of depth discrimination applies to the particular test in the Ortho-Rater.

In Figure 1 the open bars represent the non-accident and the solid bars the accident group. It will be noticed that in all tests except that of near visual acuity of the left eye, there is a greater percentage of the non-accident group passing the tests than of the accident group. These results would indicate that vision is of some measurable importance in preventing accidents.

A further study of a larger population in the plant was undertaken to confirm these results. Approximately 500 case records were separated

TESTS		Control Study of Non-Accident Cases and All Accident Cases			Power Study of 2.5% Non-Accident Cases and 100% Accident Cases		
		Percent Passing Tests			Percent Passing Tests		
		Non-Accident Group	Accident Group	Ratio	Non-Accident Group	Accident Group	Ratio
Dist.	Visual Acuity O.U.	59.9	54.7	1.09	58.4	51.8	1.01
	O.S.	57.1	42.8	1.33	48.0	50.0	0.90
	O.D.	71.9	58.4	1.22	51.2	48.0	0.87
	Worse Eye	47.8	38.1	1.24	51.2	47.8	0.86
	Depth	73.9	57.1	1.27	63.5	51.4	1.24
Near	Visual Acuity O.U.	53.3	53.8	1.40	53.5	38.2	1.04
	O.S.	50.0	51.4	0.94	57.2	36.3	0.78
	O.D.	53.3	38.1	0.86	38.4	42.5	0.91
	Worse Eye	53.8	46.7	1.70	50.5	49.9	1.08
		Median Age 40.0	Age 40.0		Median Age 44.7	Age 38.0	

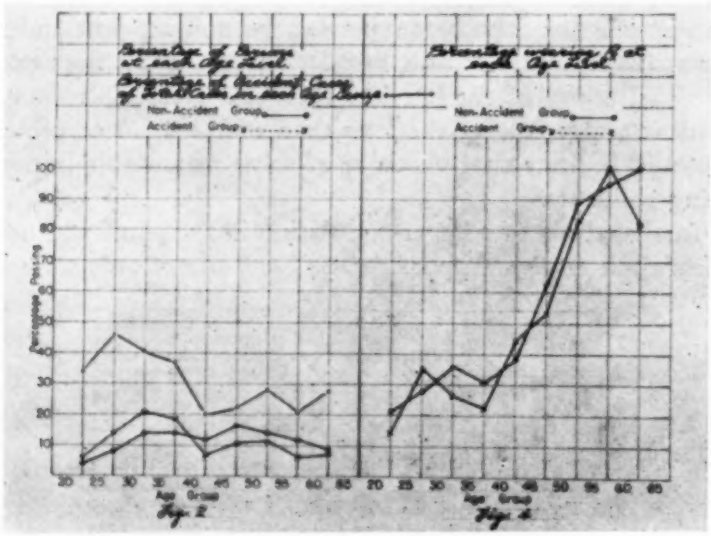
Study	Group	Percent Passing Various Levels on the Color Test						
		6	5	4	3	2	1	0
1	Non-Accident	33.4	71.3	90.5	97.6	100.0	100.0	100.0
	Accident	16.7	47.6	85.6	92.8	100.0	100.0	100.0
	Ratio	2.00	1.50	1.06	1.06	1.00	1.00	1.00
2	Non-Accident	22.8	63.1	90.0	95.5	99.1	99.7	100.0
	Accident	19.2	56.8	83.6	94.0	97.9	98.6	100.0
	Ratio	1.18	1.11	1.08	1.04	1.01	1.01	1.00

Table I.

into two groups, those showing no accidents in the previous 12 months and those showing three or more accidents during the same length of time. Some cases showed as high as 50 accidents to the same individual. This selection resulted in 331 non-accident and 146 accident cases. The Ortho-Rater records for these same individuals were then analyzed to determine whether visual performance was a contributing factor in these accidents.

Table 1 shows the percentage passing the various tests in each of the two groups as well as the ratio of the percentage of the non-accident group passing the test to the percentage of the accident group passing the same test. For comparison purposes the same summary is shown for the original study of the 84 matched cases. It will be noted immediately that with the exception of the depth and color test there does not seem to be any relation between the results obtained in the two investigations.

The depth test shows that a greater percentage of the non-accident group passed the test than did the accident group. The ratio is about the same in both studies. It is 1.27 in the first study and 1.24 in the second. Results for the color test are fairly consistent for both investigations and indicate that those individuals getting a score of four or better



are more apt to be accident free workers than those with a score of three or less.

The reasons for the lack of uniformity in results are not obvious until the age factor is considered. In the original study the groups were

matched for age and hence the median age score for each group was the same. In the second study no matching was done, the group being chosen to represent a random sample of the population in the departments from which the group was taken. Of the subjects used for the second study the median age of the non-accident group is 44.7 years while for the accident group it is 38 years. The median was chosen as a measure of central tendency since the distributions are not symmetrical. The difference in the age range might well distort the results when the group is considered as a whole. Apparently the accident group was a younger group than the non-accident one. This should have been expected for it is commonly recognized that the majority of accidents in industry are among the younger age groups.

Further consideration of the cases indicated very definitely that age must be a factor. Figure 2 illustrates the percentage of persons at each age level in the non-accident and accident groups. The upper curve shows the percentage of persons in each age group that are accident cases. Attention should be called to the sharp reduction in the percentage of accidents above the age of 40.

One of the first thoughts that come to mind under these conditions is the eye care that the individuals have had and whether visual efficiency has been maintained with advancing age. Tiffin[2] has shown very

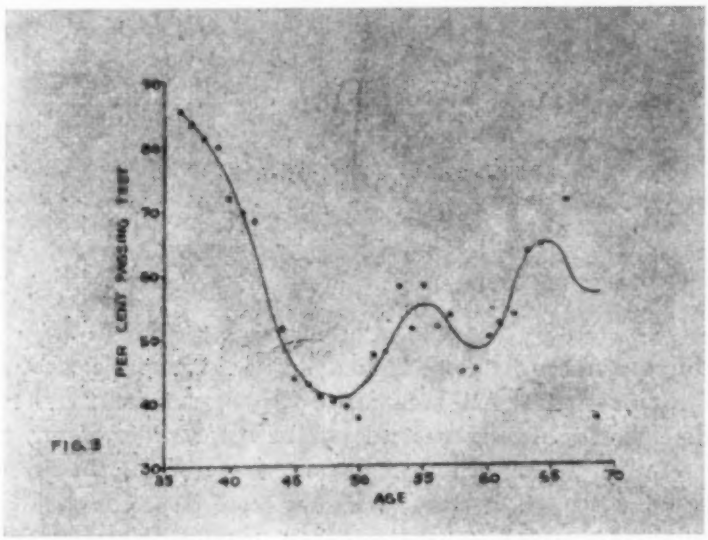
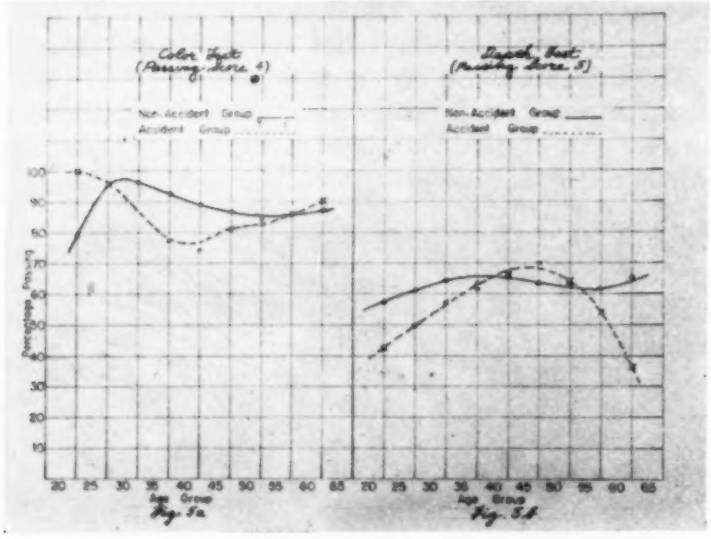


FIG. 3

clearly the effect of advancing age on near-point visual acuity. This is graphically illustrated in Figure 3 taken from Tiffin's book, *Industrial*

Psychology. The curve in this graph represents the percentage of employees at different age levels above the age of 35 who passed a near visual acuity test. The group was tested with the glasses they wore or carried with them. The figure shows that a loss of acuity is already affecting a significant portion at the age of 35, that for the whole group the loss is not arrested (by means of spectacles) until the age of 50, and that the loss of acuity is not well compensated until the age of 60, and not fully compensated for at any age.

One criterion, though not a perfect one, for classifying those that have received ocular services is whether they use glasses. This criterion was used in this study and Figure 4 shows the percentage of the non-accident and accident groups that wear glasses either constantly or on the job. Obviously, the non-accident group has received the benefit of vision care in more cases than has the accident group.



A further and more detailed analysis of the possible effect of vision in relation to accidents has been made for the various tests. Figure 5a shows the effect of the skill tested by the color slide. Using a cutting score of four, it can be seen that above the age of 30 the non-accident individuals on the whole show a higher score than the accident-prone individuals. The results of the depth test, Figure 5b, show that below the age of 40 and above the age of 55 there is a significant difference between the percentage of the two groups that score high in stereopsis.

In the graphs (Figures 6, 7, 8 and 9) showing the comparison of the two groups for visual acuity there is also a significant difference between

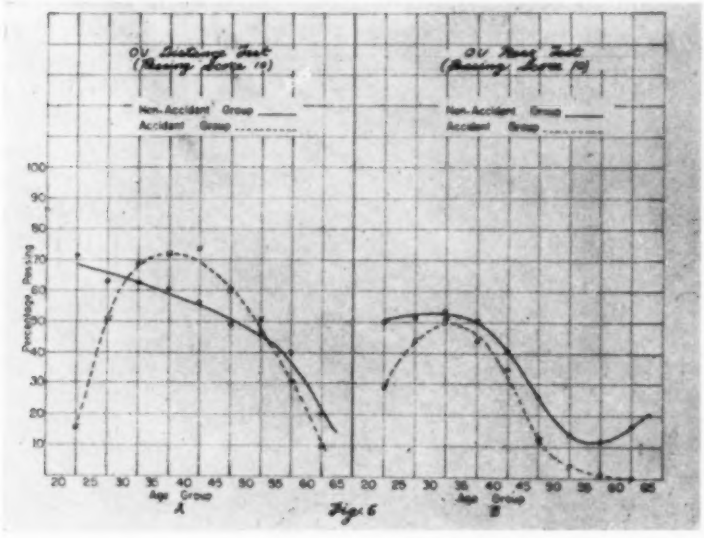


Fig. 6

the percentages passing these tests. In these graphs the curves on the left are those for distance vision and the curves on the right for near

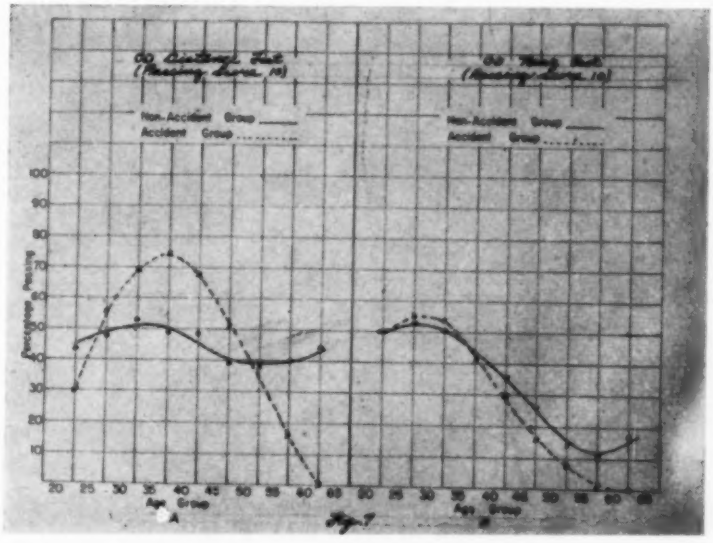
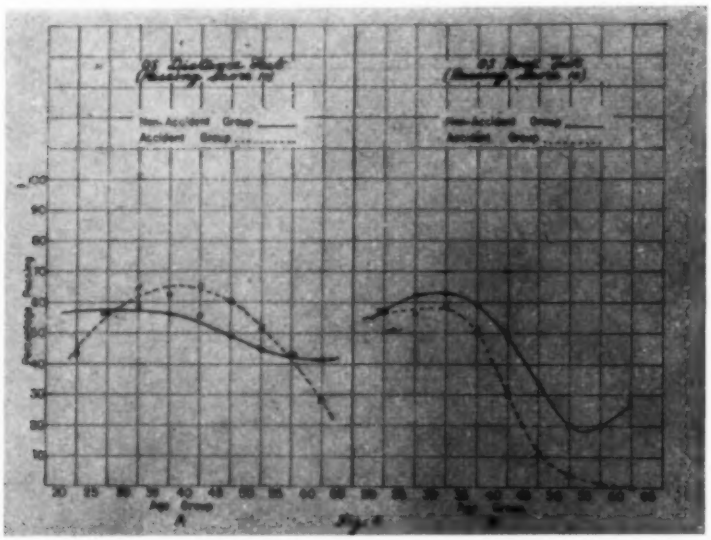


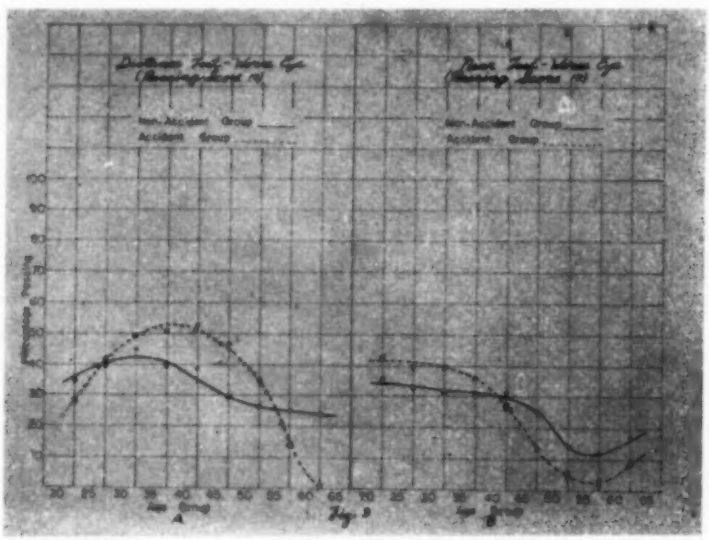
Fig. 7

vision. There are several interesting observations that can be made from these graphs. The general pattern is repeated in most cases. The curves

are interlaced for distance vision but indicate a definite superiority of the near vision of non-accident workers. The differences in the 20 to 25 year age group, while large, are not too significant because of the small



number of cases in this group. The better acuity for distance vision in the high frequency accident group among the 30 to 50 year old divi-



sions can easily be interpreted as an indication that good distance vision is not a factor in preventing accidents in this factory. The curves of the

near vision tests show very clearly that near vision is an important factor in preventing accidents, particularly in the over 40 group. This, of course, is to be expected by those among the ophthalmic professions but it has not been so readily recognized outside of those professions.

Cutting Scores and Percentage Passing for Workers Under 40							
Test	Ortho Rater Pass	Near Visual Acuity OU	OD	OS	Near Eye	Depth	Color
Cutting Score	3 to 12	8	7	8	7	5	4
Non-Accident	83.7	96.1	96.3	94.7	94.7	63.8	94.6
Accident	81.6	92.1	92.7	87.7	87.3	57.1	84.1
Ratio	1.02	1.04	1.02	1.05	1.05	1.10	1.12

Cutting Scores and Percentage Passing for Workers Over 40							
Test	Ortho Rater Pass	Near Visual Acuity OU	OD	OS	Near Eye	Depth	Color
Cutting Score	5 to 16	5	6	4	4	5	4
Non-Accident	78.5	98.5	96.1	93.1	93.2	63.3	97.1
Accident	68.4	90.2	92.3	85.4	76.6	61.9	84.3
Ratio	1.12	1.03	1.04	1.08	1.19	1.05	1.05

Table 2

Industry naturally would like to be able to sort out the accident-prone employees wherever and whenever possible. It can be readily un-

Fig. 10

derstood that it would be rather complicated to set a standard for each age group but the results seem to indicate that it would be feasible to

formulate two minimum standards, one for those below 40 and one for those 40 and older, as shown in Table 2. An analysis of the data makes it possible to set such standards. These standards and the percentage expected to pass them in each group are shown in Figure 10. Included in these standards are those for near lateral phoria.

The minimum standards for those under 40 have to be higher than for those over 40 and even then are not too discriminatory. This can be readily understood, for while vision may be a factor in safety among the younger group, others factors, such as emotional instability and carelessness, may outweigh to a large extent the visual factor. On the other hand, with the older more settled worker the visual factor becomes important and it is the responsibility of the optometrist to obtain and maintain good visual performance for his patient in order to prevent accidents

BAUSCH & LOMB OPTICAL CO
ROCHESTER, NEW YORK

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(1) Davis, C. Jane, "Correlation Between Scores on Ortho-Rater Tests and Clinical Tests," *Journal of Applied Psychology*, 30:6 (1946), pp. 596-603.
(2) Tiffin, Joseph, *Industrial Psychology*, Prentice-Hall, 1942, p. 150.

BOOK NOTICE

THE OCULOROTARY MUSCLES. Richard G. Scobee, M.D. Published by the C. V. Mosby Company, 3207 Washington Blvd., St. Louis, Mo., 359 pages, illustrated, cloth, $8, 1947.

The author reviews the anatomy and neurophysiology of the extra-ocular muscles. He then reports the results of his work at Washington University (St. Louis, Mo.) Department of Ophthalmology in correcting squint. His individual case analysis study is unique. The work done by the author follows to a large degree that of Bielschowsky. The book is thorough in covering the subject but the author's many abbreviations such as LR for lateral rectus muscles, IO for inferior oblique muscle, etc., etc., make for difficult reading. When the time comes to prepare a second edition these abbreviations should be eliminated.

CAREL C. KOCH

PURPOSIVE STRABISMUS—WITH REPORTS OF THREE CASES *

The Rt. Hon. Lord Charnwood †
London, England

There is a variety of strabismus which has not, so far as I know, been described before, and which should, in my opinion, be recognized as a separate clinical entity. I call it *purposive strabismus.*

We are all familiar with the generalization that people with squints do not suffer from headaches, or that if they do they are not due to ocular causes. I am sorry to say that I have known more than one case branded as neurotic through too much reliance being placed on this generalization.

I propose to describe, in some detail, three cases which I have seen during the past 12 months, rather than try to develop my thesis from statistics of every case which could be made to support it since this seems to make the most convincing story. Naturally I have chosen those which fit my case best.

CASE 1

The first is a young married woman of 23. Wearing her correction of + 3.0D for each eye she has an alternating convergent strabismus of between 5 and 10 degrees. Though the angle is somewhat variable, without her correction it is about 25 degrees.

She was a patient at our hospital and was investigated very carefully by three members of the staff who discussed her case together fully. Her uncorrected acuities were R. 6/6, L. 6/9. Corrected, the right eye gave 6/5 but the left remained unchanged. She can change fixation from one eye to the other voluntarily and can tell you which eye she is using at any moment. She does not experience diplopia, but any great amount of close work leads to headaches. Her sole object in presenting herself for treatment was cosmetic.

The age of onset is said to have been two months and following an attack of measles. This cannot be verified, as her mother is dead,

*Presented originally as a portion of a paper, "Some Anomalies of Binocular Vision," at the Jubilee Congress of the London Refraction Hospital, London, England. October, 1947. Submitted on December 17, 1947, for publication in the March, 1948, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist. Fellow of the British Optical Association.

but German measles seems more likely. In any case it is safe to assume that she has never possessed binocular vision.

At first sight the squint seemed to be paretic, but a careful investigation of her ocular movements convinced us that no paresis was, in fact, present; the appearance being due to the variable angle, either eye being liable to simulate a larger secondary deviation. When wearing her correction convergence acted smoothly and looked quite normal.

In view of the extremely early age of onset we felt that it would be hopeless to try to obtain binocular vision, and the headaches suggested that it would be unwise to try. It follows that operation could give only a cosmetic success with or without her correction, and that only if the variation of angle was casual.

To ascertain whether or not this was so we put up the correction for one eye in a trial frame with an occluding disc and a Maddox rod in front of the other, removing the disc at intervals to get readings. In half an hour she went from 12△ to less than two. Finally, on changing the Maddox rod for her correction and removing the disc we saw the eye turn in again to its normal position.

In view of these findings we felt compelled to advise her that the prospect of a lasting cosmetic cure from an operation was very poor.

Her headaches are not a serious nuisance to her, but taken with the other symptoms they are interesting, so I explained the situation to her and asked whether she would volunteer to undergo a week's monocular occlusion, doing all she could to provoke a headache during the period. She did volunteer without hesitation, and I would like to record my gratitude to her.

At the end of the week she reported that she had done an amount of reading and sewing which would normally have been quite impossible without a sign of a headache. A Maddox rod gave an unsteady reading of less than 1△ of esophoria with her correction. Even the streak seen through a multiple groove seemed to stimulate convergence, or as I prefer to call it in these cases, macular repulsion, and again we were able to watch the eye turn in on removing the occluding disc.

A pair of contact lenses, one of them occlusive, would give her a cosmetic cure, but this seemed a more heroic measure than her symptoms warranted, the occasional use of an occluder when specially busy being enough to keep her free of headaches.

CASE 2

My next case is a school teacher in her early fifties, a myope of approximately five dioptres showing a 30 degree unilateral convergent

strabismus on the only occasion that I saw her. I have to thank her own optometrist for allowing me to see her and for subsequent news of her.

She could give me no reliable information about the age at which it appeared or the manner of its first appearance, but volunteered the information that she believed originally the eye had turned out.

Her chief complaint was of headaches, with occasional diplopia. These symptoms had developed since her last change of spectacles, the present ones having been prescribed abroad. She also told me that the angle of the squint seemed to her to have increased greatly since the change.

She was leaving London almost at once to take up a new post. Comfort, quickly, at any price, was what she sought.

Whoever it was who had refracted her last had achieved, by the time I saw her, 6/9 in her deviating eye and had fogged her fixing eye to 6/18 from 6/6. I imagine that 6/9 had always been available in the deviating eye and that no amblyopia had been reduced, as it remains the deviating eye.

After a series of experiments in a trial frame I prescribed a full correction for the fixing eye with a lightly frosted glass for the deviating eye, and gave her an occluder that she could use if all else failed.

I have since learned that the frosted glass gives comfort, and that the angle is considered reduced, despite the increase of minus power for the fixing eye.

We hope that it will be possible for her to accept later an under-correction for the deviating eye in place of the ground glass, but I am not optimistic; once suppression has been broken down an eye does not readily learn to suppress again.

CASE 3

The third and last of this series, actually the first that I saw, is to me the most interesting and instructive.

She is an accountant aged 29, with an alternating divergent strabismus of 15 degrees, the angle being usually much the same with and without her correction of about + 5.0D for each eye, correcting to 6/6.

Again, unfortunately, no one seems to remember the exact date or mode of onset. She has worn spectacles as long as she can remember. A photograph of her, apparently about four or five years old, shows her with a convergent squint. I cannot discover when or why it changed from convergent to divergent. We do know that she has not been operated on.

The friend who referred her to me has had her under observation for seven years, during the whole of which time she has diverged and her history is one of daily headaches and of some peripheral diplopia. There was also a suggestion of neurotic trouble.

During an attempt to get her to converge by stimulating the accommodation I was surprised to see her suddenly change over to a convergent strabismus, and hold it for some seconds, even with her correction on.

The most careful investigation now fails to show any signs of a paresis; but testing with a bi-prism and Maddox rod shows a full 15 degrees of cyclophoria, equally divided between the two eyes.

In order to clear up the question of whether her headaches were or were not due to her eyes, I suggested that she should try a period of monocular occlusion. At the end of 12 days she reported that she had been completely free from headaches since the first two days, and could do an amount of reading and sewing in the evenings and at week-ends that would have been impossible normally.

On removing the occluder I saw that her eyes were parallel, but as I watched, one of them slowly turned out. The patient said that she could feel it going.

Subsequent measurements give her muscle balance as 2△ of esotropia. Several colleagues have seen her eyes diverging on removing the occluder.

As there is no known optical or orthoptic treatment for cylophoria the only choice lay between operation and permanent occlusion. The majority of the ophthalmic surgeons with whom I discussed the case favored occlusion, and the patient insisted on it. Therefore I suggested a pair of contact lenses, one of which is painted to match her own iris and rendered opaque with black enamel. With these in position she has no visible squint and, of course, no headache. On removing them the deviation has returned to its normal value in between one and two minutes; on re-inserting them it disappears in five to ten minutes.

Unfortunately, when I last saw her she could tolerate them for only two hours at a time; the rest of the day she wears a rubber occluder on her normal spectacles.

CONCLUSIONS

Considering these three cases, I find it impossible to avoid the conclusion that they are due to a purposive innervation designed to separate two retinal images that the mind cannot fuse. Such a sustained innerva-

tion would lead to headaches just as surely as the overcoming of a phoria for the sake of binocular vision.

I submit that these three cases are instances of a distinct variety of strabismus, for which I propose the name "purposive," whose peculiarity is that the innervation needed to maintain the separation has failed to become conditioned.

I am also offering the suggestion that this may be the original mechanism of the divergent strabismus of the young uncorrected myope, although, of course, in the vast majority the innervation needed becomes fully conditioned.

Mr. Watchurst, who has more experience of strabismus in children than anyone else I know, tells me that he has often seen an increase of angle accompanying an increase in the visual acuity of the deviating eye, which seems to support this conclusion.

The classical accommodative explanation is adequate to explain the breakdown of convergence, but without the mechanism that I now suggest it seems to me to be woefully inadequate to explain a deviation with the eyes looking into the distance.

The fact that no divergence center has been found does not conflict with this theory, nor does the theory postulate one that has not yet been found.

I have already referred to both the diagnostic and therapeutic use of monocular occlusion, and I should like to pause here for a few moments to discuss this test as I regard it as a most valuable one for separating those cases whose symptoms are not caused by their eyes from those we are sometimes tempted to dismiss as neurotic but whose troubles are due to some anomaly of binocular vision.

Early last year *The Optician* (London, England) gave an admirable abstract of an article on the subject by Robert Bannon of Dartmouth, and just before that L. A. Swann touched on it in one of his articles, only to dismiss it on the grounds that it was analogous to the use of cycloplegics, saying that it destroyed tonus and likening both proceedings to working on a dead eye.

The analogy with cycloplegia is obviously false, since here we interrupt an external stimulus instead of blocking an innervation. The suggestion that we destroy tonus is capable of test by experiment. Duke-Elder gives a clear definition of tonus and the factors that affect it. One component only could be affected by monocular occlusion, and that is the light tonus. I have shown that the change of tonus caused by light

stimulating one retina is shared by an occluded eye.*

True tonic contraction is maintained indefinitely without discomfort or fatigue, while any change in muscle balance or ocular posture produced by occlusion is normally accompanied by marked relief of asthenopic symptoms.

It follows that the occlusion of one eye has relieved the necessity for an innervation, either to fuse or to separate images, which has become so habitual that it is maintained through a normal cover test or even a night's rest. Such a condition would be more properly described as a spasm rather than as a state of tonus, even if not accompanied by asthenopic symptoms.

Objection has also been raised to this test on the ground that it only demonstrates Bell's effect, namely, that a covered eye tends to turn up and out, as happens under deep anesthesia and (so we are told) during sleep. Giving an observed fact a name does not explain it, nor does it help to decide if it is of diagnostic value.

We are not interested in the position that the eyes take up during sleep, anesthesia or after death. What we do want to know is the natural position of the eyes. I shall attempt to define it, but I want you to think of that description for a moment, the subject must be awake but with his eyes in the most relaxed posture attainable—in the position of minimum innervation of the extra-ocular muscles. The definition that I offer is: "the final position of rest when awake with the accommodation relaxed and the fusion sense not stimulated." I am not satisfied with that definition and, but for the loopholes that it gives for irrelevant argument, I prefer my description. I hope that someone will improve on my definition.

It is true that published records of the Marlow occlusion test show that a statistically significant majority of the eyes examined do in fact tend to diverge from their original position; they also show a tendency for the occluded eye to deviate upwards. But when studying them we must remember that most of these records refer to groups of subjects selected as likely to have some anomaly that the test would reveal, so to take exception to it on the ground that it reveals such anomalies is, to say the least, unhelpful.

During the war I tried this test on a number of subjects selected for normality, the majority of whom showed no change exceeding one prism dioptre; the few who did all proved to have a substantially lower

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**Optician*, August 8, 1947.
[London, England]

stereop-acuity than the rest.* No investigation of vertical phorias was made in this series, but a statistically significant majority of those who passed all other tests passed this one without a significant change in phoria.

Marlow has explained the high incidence of potential exophoria by pointing out that variation in the direction of an earlier state of evolution is far commoner than variation in the opposite direction, the older phylogenetic state being divergence of the visual axes.

Most workers have observed in a number of subjects a hyperphoria of one or even two prism dioptres in the occluded eye, which is transferred to the other eye when it in turn is occluded. Bielschowsky has named it "dissociated vertical divergence." These subjects generally also possess rather large vertical fusional reserves. I believe that the explanation is that we possess a very poor vertical sense of proprioception. If you close your eyes, place your finger on the wall, direct your closed eyes at the tip of your finger and then open them you will find that you are looking one or two centimetres above it. It is well known to surveyors and the like that you make a better guess at the horizontal if you hold your arm out and point before you look.

This proprioceptive lag is probably a legacy from ancestors who ran about on all fours. It results in the fixation reflex having to depress the eyes, and when the fusional reserves are large, the covered eye not being depressed enough.

When using the test it is important to remember that the first few days it is more likely to cause annoyance than to relieve discomfort, so that nothing less than 10 days or preferably a fortnight should be regarded as a fair trial. Also, if vertical phorias are under consideration, both eyes must have a period of occlusion. The other important point is that for the test to have any value occlusion must be complete and continuous, five minutes' binocular vision a day is enough to render it worthless, while partial occlusion is intolerable to many people who find relief if all light is cut off from the occluded eye

**Optician*, August 8, 1947.

108 ECCLESTON MEWS
LONDON, S.W. ENGLAND

DYNAMIC IMPRESSION TECHNIQUE OF CONTACT LENS FITTING*

J. S. Nupuf†
Canton, Ohio

FOREWORD

It has been clinically demonstrated, both in my practice and in the practices of optometrists whom I have had the opportunity to observe, that by taking an accurate eye impression and having custom-made contact lenses designed from the positive stone models of these impressions, that successful fittings can easily be had with a negligible amount of laboratory adjustments. Not only does this procedure assure the optimum of comfort and cosmetic appearance, but it also is a precise and time-saving fitting technique.

It is true that there are numerous types of custom-made contact lenses that are being made from positive models of eye impressions. It is not the purpose of this paper to discuss the merits of these various lens designs, since only by actual experience and clinical results can a practitioner appraise the different types.

I have referred to an accurate eye impression in order to obtain these expected results. This should exhibit:

(1) A large, smooth, accurate duplication of the scleral areas, free of conjunctival folds.
(2) A properly positioned cornea, with maximum inferior, nasal, temporal and slightly less superior scleral areas.
(3) Positive duplication of the extreme peripheral scleral areas, since these control the accuracy of the marginal edges of the finished lenses.

Unfortunately, accurate eye impressions proved difficult for many entering the contact lens field. Minimum practice and perfection of this skill with inadequate professional training resulted in a lowering of enthusiasm and confidence in contact lenses, which did tend to inhibit the proper professional development of this practice.

Many theories have been advanced as to the improbability of tak-

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†Optometrist. Fellow, American Academy of Optometry.

ing accurate eye impressions without the discomfort that results in this supposedly painful procedure. Yet a careful review of these theories and a study of the clinical results attained discloses the attempt advanced for the most part by interests in the trial-set fitting technique to accomplish indirectly what a proper custom-made procedure attains initially, with far less effort and fitting time required.

There is no type of lens design or theory of fitting that, in the writer's judgment, can be better adapted to the eye than a true custom-made lens.

I cannot stress too strongly the importance of an accurate eye impression. It is obvious that a lens custom-made from an inaccurate or distorted impression will manifest these inaccuracies upon the eye, requiring study and laboratory adjustments for correction. This is particularly true in fitting the larger diamond-shaped type of lenses, with their greater limbal clearance. In these lenses the scleral bearing extends more peripherally along the 180° and 90° meridians of the eyeball. It is of prime importance that these areas be accurately duplicated in the impression technique!

On April 5, 1945, we clinically investigated and introduced the report to the profession on the technique of taking eye impressions without the use of a topical anesthesia and this has since become an established and recognized clinical procedure for optometry. Numerous techniques and impression shells have been developed to simplify, and further improve the accuracy and efficiency of taking eye impressions, and thus provide a more adaptable procedure for the general practitioner.

The following impression technique, the writer believes, marks another step in the practice of fitting contact lenses, since:

(1) It is readily mastered, requiring no more skill than the insertion of any contact lens.
(2) The patient is comfortably seated in a normal upright position, and is both physically and psychologically relaxed and consequently cooperative.
(3) Clinically the procedure is more comfortable for the patient with little or no irritation during or remaining after the impression.
(4) The procedure requires far less time with increased efficiency and accuracy.
(5) Excellent results are obtainable in 95 per cent of the cases, resulting in a minimum of retakes, although retakes can easily be made, due to its lowered tissue irritating factor.
(6) Lastly the impression has proven more accurate, due to the moder-

ate dynamic force that is maintained in all directions, resulting in a more accurate peripheral scleral duplication.

THEORY OF TECHNIQUE

The principle involved in this technique utilizes a large impression lens, designed like the Nupuf diamond-shaped contact lens, having, however, only approximately accurate scleral curvatures. The four corners extend to a maximum degree to the nasal, inferior and temporal fornices. The superior is equal to that of the inferior. These lenses consist of four standard sizes: 23mm, 25mm, 27mm and 29mm.

An alginate impression cream of a constantly controlled consistency is used in the impression lens, the whole being inserted under the eyelids similar to that of any contact lens. The eyelids are closed with a squeezing action while fixation is maintained with the opposite eye. The impression cream compensates for the variances between the impression lens and the eyeball. It is pressed into position and held under slight pressure by the rigid bearing surface of the lens, creating a moderate dynamic applied force in all directions, especially at the extreme periphery. The result is a highly accurate, smooth, negative impression.

MATERIALS USED

(1) Two grams of impression powder and 8.2cc to 8.5cc of distilled water. (60°F. retards setting time.)
(2) Diamond-shaped impression lenses 23, 25, 27, or 29mm.
(3) 1½ per cent sodium bicarbonate buffer solution.
(4) Soft rubber suction nipple with large flange.
(5) Rubber mixing bowls, metal spatulas.
(6) Coecal or similar type of positive gypsum stone.
(7) One-half inch wide adhesive tape (waterproof).
(8) Red and blue soft pencils

PROCEDURE

(1) Select the impression lens that is the approximate size or slightly larger than the finished contact lens should be. Then insert this lens with the buffer solution in place, in order to verify the size and accustom the patient to the feel of the impression lens. The holes can be filled with vaseline to prevent the escape of the contact lens solution. It should feel no different than any trial-set type lens, since that in the main is what it really is. The lens should extend to the nasal-inferior, temporal fornices and well into the superior areas.

(2) Firmly attach the suction nipple to the corneal portion.
(3) Cut a strip of adhesive tape four inches long, doubling it back upon itself, exposing three-eighths inch of the gummy side; round the corners; warm over an incandescent bulb and firmly attach in the center and near the cilia of the lower eyelid.
(4) The patient should be comfortably seated in the ophthalmic chair, with the headrest adjusted to position and the eyes in the primary position, fixing a distant target. The eye is converged so that the fixating line passes through a point 12 inches from the meridian line. Heterophoria or tropia are compensated for by realignment of the fixating target.
(5) Mix the impression powder and distilled water and spatulate rapidly to a smooth creamy consistency for 1½ minutes.
(6) Fill the impression lens three-fourths full with the impression cream.
(7) Instruct the patient to sit upright and to look downward. Insert the superior flange of the shell under the upper eyelid, patient then looks straight ahead, and the lower lid is pulled down and over the lens by means of the adhesive strip. Following this procedure the lens is suspended away from the eyeball with the attached suction nipple.
(8) Patient is sitting upright, head positioned comfortably against the headrest, and the opposite eye fixating the target.
(9) When fixating is steady, apply moderate pressure with the suction nipple, and remove it from the lens. Nipple may be easily removed by grasping with fingers close to flange. The eyelid is then closed over the lens and the patient instructed to squeeze the lids in order to apply pressure upon the lens from all directions. Steady fixation is maintained with the opposite eye.
(10) A cold gauze compress is applied over the closed eyelids and held in place by the patient.
(11) After the impression material has set approximately two to three minutes, the gauze is removed which should carry with it any excess that has been squeezed out over the eyelids.
(12) A blue 180° line with the pupil of the fixating eye is then marked over the impression lens. Red markings are made in line with the center of the nasal and temporal fornices. Note: The red markings are used for accurate shaping of the diamond-shaped lens.
(13) The suction nipple is firmly attached to the lens and the lens re-

moved by instructing the patient to look down and with a slight temporal rotating and wedging motion, the superior area is eased away from the eyeball, the patient looks up and the impression lens removed from under the lower lid. Should the superior flange be excessively large, instruct the patient to look up, and while the lower lid is pulled down and under the impression, gently pull the inferior section off the eyeball while slightly rotating the temporal ward. As the suction is broken, the patient looks slowly downward and the impression carefully lifted out from under the upper lid.*

(14) The eyeball is flushed with the buffer solution and inspected for any residual impression material. It is very rare that alginate particles remain since the total mass adheres together when properly set.

(15) The negative impression with suction nipple attached is placed upon a three-fourths inch bottle opening and filled with fixing solution for three minutes while the stone is being prepared.

(16) The fixing solution is poured out and any remaining pool soaked up with long fiber cotton.

(17) The stone is carefully vibrated† into the negative, adding small amounts, usually one-third at a time until it is filled. Then an additional amount is piled near the center and carefully leveled by a cutting action with the spatula.

SUMMARY

(1) A simple procedure of taking impressions which is readily mastered is presented. The patient remains in a seated position.

(2) With the suggested procedure the patient is psychologically more at ease, hence a more cooperative patient, and is not frightened by the operative-appearing technique of being reclined in a horizontal position either in an ophthalmic chair or an operating-type table.

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*Note: It is often advisable to have the assistant or patient hold the upper lid in order to prevent blinking at the moment the impression is being removed, as a precaution against breaking off any of the superior flange that may project past the rim of the lens.

†Vibrate the stone thoroughly. Many an excellent impression has been ruined by careless stone preparations. Transfer the blue and red markings to the stone model after it has become firm to a scratchtest. However, do not remove from the negative for at least 45 minutes. The writer does not believe in total immersion of the negative in the fixing solution since the solution could penetrate the space between the lens and the impression, distending the impression and resulting in inaccuracies. For that reason, we fill the negative and pour each model immediately, instead of taking both eye impressions and pouring up both models. The hygroscopic alginate immediately starts to change dimensional shape if left exposed to the air.

Very often the first eye can be started before the patient is aware that an actual impression is being taken. Once the patient experiences the ease and comfort of this technique he is receptive to the taking of the opposite eye and to any retakes that may be necessary for perfect positive models.

(3) The overall directional force, maintained by the squeezing action of the eyelids, upon the impression lens, results in a fine smooth duplication of the scleral contours, precisely accurate to the marginal areas, which in effect becomes the important peripheral portions of the finished contact lenses.

(4) The ability to close the eyelids with no irritation to the sensitive ciliary margins is highly advantageous. This has been impossible with our former handle-type impression shells.

(5) Since the impression lenses are precisely designed with a minimum of protrusion, the eyelids do not become unduly stretched so that a large impression lens with a resultant large negative impression can be obtained without difficulty of removal or discomfort to the patient.

(6) The simplicity and ease of this technique both for the practitioner and the patient, together with the exceptionally high percentage of excellent eye impressions, assure a substantial advancement in the practice of fitting contact lenses.

1342 N. CLEVELAND ST.
CANTON, OHIO

BOOK NOTICE

PRINCIPLES OF THE CONTACT LENS. H. Treissman, M.D. and E. A. Plaice. Published by the C. V. Mosby Company, St. Louis, Mo., 88 pages, illustrated, cloth, $3.50, 1947.

This book to a very large degree is a review of the work of Dr. Josef Dallos, ophthalmologist of Budapest, who is credited as doing some of the recent European advanced work on moulded contact lens fitting. The authors are British specialists in contact lens fitting who use large lenses made of glass rather than plastics.

CAREL C. KOCH

DVORINE COLOR DISCRIMINATION SCREENING TEST*

Israel Dvorine†
Baltimore, Maryland

The experience gained during the last three years from the use of the DVORINE COLOR PERCEPTION TESTING AND TRAINING CHARTS has prompted many to request an additional color discrimination test of a limited number of charts, for rapid screening of individuals with defective color vision. The author's two volume set of pseudo-isochromatic charts was designed not only to select the normal from the so-called "color-blind," but also to make available for the practitioner a means of diagnosing the specific color combinations which the color weak confuse as well as the relative degree of their color weakness. Obviously, such a test requires a leisurely approach to the problem of testing as well as adequate time to complete the diagnosis.

Since most authorities agree that only 5 to 10 per cent of the males and less than one per cent of the females have defective color vision, an abridged color test with which one could immediately establish that the person tested has normal color vision and yet have the test accurate enough to baffle those who have defective color vision would result in a great saving of time for those practitioners who merely desire to ascertain whether the person tested has, or has not, defective color vision. This time element is especially important when a large number of individuals are to be examined in industrial plants and in schools.

To be practical, the screening test must be instantaneous, requiring only a few seconds to complete it, and its results must compare favorably with other more complicated color vision tests. For this purpose, the author has selected two color combinations which he used in his two volume set and which have been proven to cause more confusion among individuals with defective color sense than any other group of color combinations. These colors are orange and green, and blue and purple, respectively. Two new charts were designed with double digits in each one. To prevent malingering, a duplicate set of charts was designed with the same color combinations, known as Group B, but with digits different from those of the first group, known as Group A. Each group con-

*An abridgment of the material presented at Johns Hopkins University before the Maryland Psychological Association on November 5, 1947. Submitted on December 8, 1947, for publication in the March, 1948, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist, Fellow, American Academy of Optometry.

sists of two pseudo-isochromatic charts bound securely in a plastic-backed cover with the pages opening flat for the convenience of the examiner as well as for the patient.

In the performance of the test, the examiner exposes one chart at a time, at a distance of about 16 inches from the patient, using daylight illumination or illumination by a daylight bulb of not more than 100 watts. If the individual's color discrimination is normal, he will report within a few seconds that the digits of Group A are 23 and 92. If Group B is used, he will report that the numbers are 32 and 63. If the examiner has reason to doubt the patient, then both groups of charts should be used and, in addition, the patient should be asked to outline the numbers with a thin brush or with some other pointer. Young children and pre-school age youngsters can be tested with this group of charts without any difficulty. If the child is not yet acquainted with numbers, the examiner merely asks the child to outline the figures, and if the child has good color discrimination ability, he will do so with ease.

Although this color discrimination screening test has only recently been published, two reports of its use are already available. Table A is a summary of the screening of 73 office patients. Since the author's interest in color vision is public knowledge, the number of individuals with defective color discrimination who consult him is therefore higher than that of the average optometrist. The ages of the patients ranged from 5 years to 80 years. Table B is a summary of the screening of 206 college students, ranging in age from 17 to 23 years.

TABLE A

OFFICE PATIENTS

Men tested		41
Passed without difficulty		30
Passed with difficulty the blue-purple		2
Failed the orange-green and blue-purple		9
Failed one chart only		0
Aware of color difficulty		7
Unaware of color difficulty		2
Youngest patient to fail	age	11
Oldest patient to fail	age	60
Women tested		32
Passed without difficulty		28
Passed with difficulty the blue-purple		2
Failed the orange-green and blue-purple		2
Failed one chart only		0
Aware of color difficulty		1
Unaware of color difficulty		1
Youngest patient to fail	age	49
Oldest patient to fail	age	50

TABLE B

COLLEGE STUDENTS

Men tested	190
Passed without difficulty	163
Passed with difficulty the blue-purple	9
Failed the orange-green and blue-purple	18
Failed one chart only	0
Aware of color difficulty	14
Unaware of color difficulty	4
Women tested	16
Passed without difficulty	16

One significant factor is obvious in both tables. When an individual with defective color discrimination failed the orange-green combination chart, he also failed the blue-purple chart as well; in no instance did anyone fail one chart and pass the other. A small number of those who passed had some difficulty with the blue-purple combination, necessitating a few more seconds for the study of the chart before the digits were correctly called. This difficulty may not be the result of defective color vision but merely a weakness in figure-background discrimination. In any case, the correct naming of one digit of a group of two would, of itself, indicate that the difficulty is not in the ability to discriminate the specific colors exposed in the chart.

All of the office patients who failed to pass the screening test were examined again with more elaborate tests* and all of them showed the usual weaknesses for certain specific color combinations that are generally found in the so-called "color-blind" individuals. In no instance did a patient fail the screening test and later pass a more complicated and lengthy test. The college students who failed the screening test were not available for a retest, but in view of the fact that 14 out of 18 who failed were aware of their color difficulty (because of previous tests in the army, etc.), it is reasonable to assume that the results of the screening test compare favorably with other tests which require more time to reach the same conclusion.

SUMMARY

1. The author has described a new color discrimination screening test consisting of two groups of pseudo-isochromatic charts known as Group A and Group B. Each group consists of two charts whose color combinations are orange and green, and blue and purple, respectively.

*1. Dvorine Color Perception Testing and Training Charts
2. Ishihara Charts
3. A. O. Co. Pseudo-Isochromatic Plates
4. Holmgren's Worsted Test for Color Blindness

2. The advantage of this screening test is that it is instantaneous, requiring only a few seconds to complete, and its results compare favorably with the results of testing with more complicated and lengthy tests.

3. Two tables are given showing the results of the screening of two groups of individuals. Table A consists of 73 office patients, ranging in age from 5 to 80 years—41 males and 32 females. Of this group, nine males and two females failed to pass the screening test. Table B consists of 206 college students, ages 17 to 23—190 males and 16 females. Eighteen males of this group failed to pass the test. All of the females passed the test.

2328 EUTAW PLACE
BALTIMORE, MD.

BOOK NOTICE

MANUAL OF OCULAR PATHOLOGY FOR OPTOMETRISTS. George A. MacElree, Jr., O.D. Published by the Press of the Pennsylvania State College of Optometry, 12th and Spencer, Philadelphia, Pa., 5th edition, 494 pages, cloth, $8, 1947.

The author, a member of the American Academy of Optometry, is Professor of Ocular Pathology at the Pennsylvania State College of Optometry. This fifth edition is quite similar to the four which preceded it, having as its major addition a chapter on the ocular manifestations of systematic disease.

MacElree writes well. He keeps his sentences short and eliminates much extraneous material usually found in a text on pathology. He follows the usual anatomical outline of presenting his subject. Then reviews each pathological entity, giving the symptoms, clinical picture, etiology, pathology, course, sequelae, prognosis and a brief review of the treatment.

This well written manual should be in every refraction room as a quick reference for day to day use.

CAREL C. KOCH

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THE EDUCATIONAL PROGRAM OF THE ACADEMY MEETING

At the last meeting of the Academy in Chicago, December 13, 14, 15, and 16, 1947, the activities of, and the interest expressed in, the general educational program and, particularly, in the section meetings indicated the value of the entire program and the worthwhile aspects of the sections on orthoptics, contact lenses, and aniseikonia. On each of the four afternoons two full hours were set aside for each section to hold its educational lectures, demonstrations, and discussions. Thus, there was a total of eight hours devoted exclusively to orthoptics, contact lenses, and aniseikonia. This arrangement permitted much more concentrated attention to each specific subject than would be possible if papers on each subject were delivered consecutively.

In general, the entire program at our last Academy meeting was

one of the best in the history of the Academy. Besides the papers presented in the three sections, there was a total of 20 other papers delivered before the general assembly. While a few of these papers dealt with important theoretical matters, the majority of the papers reported on clinical data and clinical techniques. Most of the material presented before the general assembly treated subjects not covered by the sections; however, there was an exception with respect to contact lenses. Five of the 20 papers read before the general assembly had to do with various aspects of contact lenses and normally these five papers should have been presented before the section on contact lenses. It must have been the opinion of the respective authors and/or the judgment of the program chairman that these five papers were of sufficient general interest to warrant their presentation in the general program rather than before the contact lens section only. No doubt, another factor was that the section on contact lenses had planned to devote the major portion of their time to organizational details, particularly, the matter of certification of contact lens specialists, as reported in the January and February issues of our Journal. This latter matter is an important one and may be followed by the other sections. However, it is hoped that future meetings of the various sections will devote a major portion of their time to presenting educational material in their respective specialties.

Various members who attended the meetings volunteered their opinions relative to the advantages and disadvantages of having certain papers presented only before a group attending a section meeting. In general, the advantages expressed were:

1. More papers on one specific specialty are possible.
2. The sections bring together men of like minds and similar interests on certain subjects which do not interest the general membership to an equal extent.
3. Specific instruction and demonstrations can be done best in small groups such as the sections.
4. The section meetings can combine the dignity of the general Academy meeting with the informality of small group seminars.

The chief disadvantage of the section meetings seemed to be for a few men who were very much interested in the subject matters presented by each of the sections and because these meetings were scheduled concurrently, it was impossible for them to attend all of each section's meetings. However, this disadvantage can be overcome by the publication of the important papers that were read before each section.

The largest attendance at the section meetings was in the or-

thoptics section. This is understandable since orthoptics is an important subject for most optometrists. Principal speakers on the orthoptic section program were Drs. Daniel Woolf, Glenn Fry, Meredith Morgan, and Harold Haynes. In addition to the presentation of papers, there was ample time for question-and-answer periods. All who attended the orthoptics section meetings were very much satisfied and many expressed the opinion that the same type of program should be continued.

The contact lens section attracted many interested Academy Fellows and under the able leadership of Dr. John Neill plans were formulated for establishing the qualifications, methods of examinations, and eventual certification of their members as specialists in the field of contact lenses. Besides Dr. Neill, other prominent figures in the contact lens section meetings were Drs. Feinbloom, Freeman, Nupuf, Hummel, Bridgman, etc. The knowledge and experience in contact lens work of these men insure success to the activities and recommendations of this section.

The section on aniseikonia had a well prepared program with theoretical and clinical lectures, as well as a demonstration of a new model eikonometer. Although those who attended the aniseikonic section meetings were keenly interested in the subject, the number of Fellows was relatively small compared to the attendance at the meetings of the other sections. This may be accounted for by the fact that aniseikonia is a specialty which has been brought to the attention of optometrists only in recent years and not many are engaged in this work. Furthermore, the fact that instruments for detecting and measuring aniseikonia are not available immediately does not encourage those who might wish to know more about the subject. Lectures before the aniseikonic section were delivered by Drs. Paul Boeder, Harold Fisher, V. J. Ellerbrock, Oscar McCulloch, Rudolph Textor, and the writer. It is to be expected that if aniseikonic instruments are available in the near future greater interest will be manifested and there will be a demand for basic courses in aniseikonia that may well be initiated by the Academy's section on this subject.

While general optometric topics, particularly with respect to fundamentals of refraction, patient handling, significant case histories, and new phenomena, will always interest the Academy body and will continue to be the main feature of our meetings, nevertheless, it is obvious that the "specialties" represented by the sections in the Academy will play an increasingly important part in the educational meetings of the Academy and, therefore, will be an influence on the profession of

optometry as a whole. Furthermore, as the respective sections present the results of current research and give advanced instructions, the caliber of their members will be developed to aspire toward higher standards of practice which will not only be a distinct credit to the profession but, more important, will assure better service for the public welfare. The contact lens section has already begun to establish means of accrediting those who are most competent in this specialty and the other sections will, no doubt, soon adopt some form of identification of those who are expert in their respective fields. This will enable not only the members of our Academy and optometrists in general to become familiar with the leaders in the various specialties, but it should provide an index for the information of the interested public, military and government agencies, social welfare, and related professional organizations.

ROBERT E. BANNON

SPECIAL REPORT

SHORTAGE OF OPHTHALMIC MATERIALS IN GERMANY*

William P. Schumann†
Vineland, New Jersey

During the last few months, many optometrists in America have been asked by their patients to fill prescriptions for friends or relatives in Germany. These prescriptions were written by German optometrists and ophthalmologists. Although these optometrists do not fill prescriptions, they arranged with the laboratories to make the glasses as ordered so that needy persons in Germany could maintain mankind's greatest gift—human vision.

In my own practice, where I have a number of patients with relatives abroad, I have obtained for them, for instance, a + 2.75 D.Sph., and the lenses were sent uncut to the relative to be placed in the frame by the German optician. Having been raised and introduced to optics in Germany, I was rather amazed to find the Germans asking for such simple prescriptions, and wrote a former classmate and friend who studied with me at the Jenaer Fachhochschule für Optiker (technical school) about the situation. Through him I obtained the true and

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†Optometrist. Fellow, American Academy of Optometry.

rather desperate picture of the plight the Germans find themselves in as far as glasses are concerned.

My friend practices in a city not far from Cologne and the university city of Bonn on the Rhine, which is in the English zone of occupation. So that I could get a firsthand view of the situation, he sent me the new magazine called "Der Augenoptiker" (Eye-Optician), from which I shall quote at times the official edicts.

About 85 per cent of Germany's optical industry is located in the Russian zone. This includes the manufacture of precision instruments and the ophthalmic division. It is well known that the Zeiss works was completely dismantled. However, the major portion of the ophthalmic materials came from Rathenow, not far from Berlin, which was often referred to as the eye of Germany. Here were the greatest works of Europe as far as the ophthalmic industry was concerned—Nitsche & Guenther, Busch, Rapsch, etc. There was hardly a house in Rathenow that was not used for the manufacture of lenses or frames. The firms mentioned above were dismantled 90 per cent and sent to Russia. The smaller ones had a similar fate, and the dismantling still continues. The machines left in the factories were old and needed repairs badly.

In Rathenow, the Russians instructed the workers to start one-man shops. Now it is impossible to get production going, as one man cannot attend to all operations. Even if the one-man shop idea would work, they could not go into operation because as new manufacturers, no material is available to them. No new business enterprises are allowed in any zone. The same holds true if an optician (optometrist) wants to open his own practice. He cannot get permission, and his name is put on the list so manufacturers cannot sell him any merchandise.

Of the lenses and frames made in the Russian zone, the greatest amount goes for reparation, and since no quantity or time limit as to reparation has been set, this can go on indefinitely.

Der Augenoptiker No. 22, October 20, 1947, has this to say about the production which is not taken as reparations:

"The delivery of optical materials to the west zones is practically non-existent, because 80 per cent of the whole production is for reparation and the other 20 per cent for the eye opticians of the eastern zone. The distribution of these finished products is made through the Optische Ein-und Verkaufsgesellschaft (optical distributing company) in Rathenow, through which the English zone has received since 1945 until

today 100,000 lenses. The amount for the American zone might be the same. While previously the eastern zone produced 20 million lenses in a year, the production of the still operating factories in Rathenow is 2 million a year.

"Of these 2 million, the reparations come first. With the complete dismantling of Zeiss, Jena, the Glassworks of Schott & Genossen, Jena, and the other great concerns—Nitsche & Guenther, Busch, etc., and with only about 100 of those small factories operating, the future of the Augenoptiker is rather black."

The dismantling of the Zeiss works is rather paradoxical. The Russians are the proponents of communism, and here they have taken the only optical factory in the world, which I believe belonged to the workers—in other words was socialized—away from the workers they want to protect, and whose social welfare is paramount in their mind. Perhaps their communism is another brand. What is not very well known here is that Zeiss belonged to the workers since about 1900, and its statute was the Carl Zeiss Stiftung (Carl Zeiss Foundation).

Carl Zeiss was a University *mechaniker* who worked for the university in Jena, and he found that without higher mathematics he could not produce the microscopes demanded from him. He got in touch with Ernest Abbe, who came from very poor circumstances, and who was a *private docent* (instructor) at the university. He designed the microscopes but found he could not go ahead as the glass was missing. Here entered Otto Schott who founded the glassworks, financed by $1,000 from the Prussian government and monies from Zeiss and others; therefore, the name Schott & Genossen (Company). Under the direction of Abbe, the Zeiss works grew in great strides. When Zeiss died, his share of the business went to his son, Roderich, and Abbe, who was never happy with the riches he accumulated, founded the Carl Zeiss Stiftung. It shows how humble the man was in giving the name of the foundation the one of the founder. The document creating the Stiftung was a masterpiece and five universities gave Abbe the honorable doctor degree of jurisprudence.

The social conditions and improvements at Zeiss were tremendous. To my knowledge, there was never a strike since its inception. At the end of the year every worker shared in the dividends. May I also mention that Abbe gave all the money he made to the Stiftung retaining only a small salary until his death. A certain amount of the Stiftung went back to further science. The University was practically supported by the Carl Zeiss Stiftung, and in thought it was one of the most liberal

universities in Germany. Out of the Carl Zeiss Stiftung came the optometric college, then given to the State of Thuringia. Zeiss had nothing to do with it, except that various men of Zeiss, Henker, Hartinger, v. Rohr, etc., lectured there honorably.

Otto Schott followed the example of his friend Abbe and in the 1920's included Schott & Genossen in the Zeiss Stiftung. The fate of this institution is a great blow to all who know the true history of Zeiss and the social benefits it created.

The New York Times had a special report by Edwin R. Murrow from Jena on January 17, 1948. Murrow stated that the recovery of the Zeiss works is near. In an interview with Dr. Hugo Schade, director of the foundation, it was revealed that Zeiss manufactures about 80 per cent of its pre-war volume of lenses for cameras. Approximately 6,500 people are working compared to 11,000 before the war. Dr. Schade pointed out that they only make lenses for cameras, none for microscopes or spectacles. Only 1573 machines of 10,000 were left by the Russians and at present 1,200 are in operation. The correspondents were impressed with that recovery unparalleled anywhere in Germany. The production of field glasses, opera glasses, and other optical equipment is to be resumed in a month. So far the Zeiss works have spent 40 million marks to get going again.

Dr. Schade did not know what the total reparations by the Russians would be. Schade further stated that an equal recovery is taking place at Schott & Genossen. He further stated that the removal to Russia of 270 top scientists did not affect him as much as the 83 taken by the Americans when they went into Jena. The Russians added in a German paper from Berlin that "the Americans robbed 60 freight cars full of research results, so for the next 25 years American optical researchers can sleep quietly."

No matter when the production of frames and lenses is resumed, the benefits will not be felt in the western zones. Of all productions, reparations will be extracted first and always. To increase the difficulties of the optometrist in the western zones, the British military government has now decided to dismantle the only factory in the British zone of any importance, the one in Goettingen, Jos. Schneider G.m.b.H., which made lenses and frames. The German optometrists have protested with no results as yet. According to Der Augenoptiker No. 23, November 10, 1947, "the dismantling of the Schneider Werke must under all circumstances be prevented, even if perhaps later its reestablishment

would be permitted, as at present with the loss of that production the amount would fall below 7½ per cent of that needed."

In view of the fact that we have to pay for the Marshall plan, it seems to the writer that a further dismantling of German factories goes against the results planned by Marshall. There is no doubt that glasses are necessary for health but also to production in any endeavor, and since a recovery in Europe without industrial Germany is impossible, we should take notice of this fact whether we like it or not. The manufacture of lenses and frames certainly is peaceful. Furthermore, the men who work in those factories are highly skilled, and with the dismantling of the factory they are unable to find work, and as a result there is unemployment, and the first step to drive the people into the arms of communism is taken. There have been attempts to get workers out of the Russian zone, but they are reluctant to go. First, they have their homes in that zone; secondly, the British or American zone will not let them come in on account of food shortages.

The same difficulties are what the Germans call Kunststoff industry (synthetic industry). We can translate that in the famous word "Ersatz." In this category fall the shell frames. The Germans relied very much on the celluloid frames as gold-filled frames and nickel frames are not available at all. The production in the Russian zone in 1942 was 280 tons, in the French zone, 150 tons, and in the combined English and American zones, 380 tons. Today in all four zones only 50 tons are being produced. The greatest trouble is that they cannot get camphor which is made from turpentine, which is imported in very small quantities from Switzerland only. The low production of the shell frames needs 3-4,000 tons of coal, while they obtain only 1,600 tons. If they cannot get turpentine soon, the shell frames will be discontinued. (Augenoptiker No. 23, November 10, 1947.)

A further difficulty lies in the fact that they cannot get emory, rouge, pitch and felt, or steel for their laps. At present, 125,000 lenses a month are made while they need 800,000. Those lenses are distributed over 1,200 Augenoptiker and they consist only in numbers from plano to -5.00, nothing higher and no astigmatic lenses. Due to this small range in numbers made, there is often an overlapping while certain numbers are on the shelf of the optometrist, the others he cannot fill, therefore the percentage is less. (Augenoptiker No. 23, November 10, 1947.)

Often in radio and newspaper reports the public has been misled

into thinking that new factories for lenses and frames are in operation in the British zones. People who had waited for months rushed to the optometrist and demanded their glasses. The optometrist had the hard job of convincing the patient his plans couldn't be fulfilled. This happened so often that the optometrists wrote an article in the Rheinische Post (Rhine Post), Düsseldorf, and gave the true picture of their dilemma.

Düsseldorf is a city of about 600,000 inhabitants and the article stated that to satisfy only half the people of the city they would need 500 lenses daily, which means 180,000 lenses a year, which is practically the whole German production. The same is true of frames. The only supplies the opticians are getting are repair parts, and from those they try to make a living. The prices are regulated, and for instance, the cost to the optician in the Russian zone for a lens is five marks, and he is allowed to charge the patient only five marks, which creates a hardship on all.

The factory of Rodenstock, Munich, works for the demand of the American army, at least at the moment. Furthermore, Rodenstock is idle most of the time, because the dam which stops the river Isar is broken, and since it generated the electricity for the factory, there, too, is no hope.

In the neighborhood of Hannover in the British zone there are some glass facorties, but their production is curtailed as the electric current is shut off for days. (Augenoptiker No. 24, November 30, 1947.)

No companies from the French zone are listed in the paper, which in my opinion is strange, for the French zone is for all practical purposes just as completely shut off as the Russian zone. In Bad Kreuznach is the Optical Work of Jos. Schneider & Company, well known for their camera lenses. It was in this factory that I learned the intricacies of grinding precision optics. The factory employed 800 people, and until a few weeks ago was worked by the French government to capacity. In the last letter from a cousin of this town I learned the French are dismantling this factory. There is another factory making lenses for spectacles most of which go for reparation and the rest probably are used in the French zone, therefore nothing is available for the Germans.

There is one new factory in Oberkochen, Württemberg, in the American zone. It is the Zeiss-Opton, G.m.b.H. Zeiss-Opton was founded by Dr. Karl Bauersfeld, the creator of the Zeiss planetaria, which can be found in our big cities. Zeiss-Opton will be run according to the Carl

Zeiss Foundation by men and scientists who got out of Jena. So far they only repair Zeiss instruments, and state that any requests for lenses, frames or new instruments cannot be filled. (Augenoptiker No. 23, November 10, 1947.)

There are even more difficulties confronting the Augenoptiker. In order to receive 12 frames in "iron" (nothing else can be obtained), he has to send in one gram of silver and 250 grams of brass or copper. For one mechanical drawing set he needs three kilograms of the above mentioned materials. The people help to a certain extent by bringing in, for example, old faucets and cartridges. Also, to get the frames he has to send the company the box to ship it in. All of which explains why in Germany today out of 100 patients only 7 can be taken care of. It is also natural that under those circumstances there is nothing in Germany approaching professional eye care. The people go from one optometrist to another in the hope that one of them might have the lenses they need and all in vain. Surely the people have the *Krankenkassen* (health service), but what good is it to know what correction you need or what medication should be given to you if it is unobtainable.

Nowhere is there a ray of hope that the next year or the following might bring a change in the situation. The circle is too vicious and the shortages of all necessities too great to expect any kind of recovery.

It is my opinion that Germany's optical industry has been driven from its high pinnacle and that the American optical industry will resume the place which was Germany's for so long. The German nation has now become an importer of optical goods and only America has the optical industry capable of filling the optical needs of the world.

511 LANDIS AVE.,
VINELAND, N. J.

REFERENCES

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TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

ACADEMY COMMITTEE APPOINTMENTS FOR 1948

Dr. Harold M. Fisher, president, reports completion of 1948 committee appointments, as follows:

CONSTITUTION AND BY-LAWS COMMITTEE

Dr. D. G. Hummel, Cleveland, Ohio, chairman; Dr. Arthur P. Wheelock, Des Moines, Iowa, and Dr. Carel C. Koch, Minneapolis, Minnesota, committee members.

This committee is a newly-created group charged with studying and revising the present rules and regulations of the Academy. The work of this committee will be reported to the membership by bulletin or at the latest at the next annual meeting.

ADVISORY COMMITTEE

The following Academy members have been appointed to serve on the advisory committee: Dr. J. Fred Andreae, Baltimore, Maryland, chairman; Dr. Arthur P. Wheelock, Des Moines, Iowa; Dr. Don R. Paine, Topeka, Kansas; Dr. Carel C. Koch, Minneapolis, Minnesota; Dr. Thomas R. Bell, Alpena, Michigan; Dr. George L. Brown, Paulsboro, New Jersey; Dr. C. J. Hathaway, Pontiac, Michigan; Dr. William M. Kinney, Los Angeles, California; Dr. John W. Mogey, New York, New York; Dr. John R. Wittekind, Morrisville, Pennsylvania, and Dr. George W. Keevil, Toronto, Canada.

CHAPTERS AND NEW CHARTERS COMMITTEE

Appointed to serve as a liaison group between the parent body and the chapters are the following: Dr. W. Edward Dewey, Battle Creek, Michigan, chairman; Dr. A. G. Billmeier, Denton, Maryland; Dr. W. I. Brown, New Bedford, Massachusetts; Dr. L. G. Chase, Springfield, Vermont; Dr. O. H. Johnson, Jonesboro, Arkansas; Dr. J. W. Mogey, New York, New York; Dr. J. R. Shreve, Indianapolis, Indiana; Dr. W. O. Vivian, Media, Pennsylvania; Dr. R. N. Walker, Winston-Salem, North Carolina; Dr. G. H. Warkentine, Cedar Rapids, Iowa, and Dr. C. H. Wiesepape, Columbia, South Carolina.

COMMITTEE ON NOMENCLATURE AND STANDARDS

This committee is charged with the responsibility of making recommendations to the profession for keeping the nomenclature and refractive standards of optometry uniform.

Chairman, Dr. Glenn A. Fry, Columbus, Ohio. Committee members: Dr. Julius Neumueller, Philadelphia, Dr. Robert Graham, Pasadena, California.

COMMITTEE ON RESEARCH

Dr. Robert E. Bannon, Columbia University, New York, chairman; Dr. Henry A. Imus, Washington, D. C., Dr. Glenn A. Fry, Columbus, Ohio; Dr. J. Donald Kratz, Philadelphia, Pennsylvania, and Dr. Meredith W. Morgan, Berkeley, California, committee members.

EDITORIAL COUNCIL

The following group was appointed by President Fisher to serve on the editorial council of the Academy: Dr. Carel C. Koch, Minneapolis, chairman; Dr. J. Fred Andreae, Baltimore, Maryland; Dr. Robert E. Bannon, New York, New York; Dr. I. M. Borish, Kokomo, Indiana; Dr. Milton N. Chodroff, Brooklyn, New York; Dr. Harold M. Fisher, Mt. Kisco, New York; Dr. Glenn A. Fry, Columbus, Ohio; Dr. Henry W. Hofstetter, Columbus, Ohio; Dr. D. G. Hummel, Cleveland, Ohio; Dr. E. A. Hutchinson, Los Angeles, California; Dr. E. J. Margaretten, New York, New York; Dr. Meredith W. Morgan, Jr., Berkeley, California; Dr. Julius Neumueller, Philadelphia; Dr. Carl A. Radde, Cleveland, Ohio; Dr. Harold Simmerman, Woodbury,

New Jersey; Dr. C. L. Treleaven, New York, New York, and Dr. Arthur P. Wheelock, Des Moines, Iowa.

LIBRARY-MUSEUM COMMITTEE

Dr. E. LeRoy Ryer, New York, New York, chairman; Dr. Henry Hofstetter, Columbus, Ohio, and Dr. Richard M. Hall, Cleveland, Ohio.

POLICY COMMITTEE ON SCREENING TECHNIQUES AND REVIEWING NEW INSTRUMENTS

Dr. V. J. Ellerbrock, Columbus, Ohio, chairman; Dr. E. LeRoy Ryer, New York, New York; Dr. E. L. Higgins, Cleveland, Ohio; Dr. Herbert G. Mote, Columbus, Ohio, and Dr. F. W. Sinn, Philadelphia, Pennsylvania.

PROGRAM AND PAPERS COMMITTEE

As announced in our January issue, Dr. Harold Simmerman, Woodbury, New Jersey, will again be in charge of this committee. Appointed to serve with him are: Dr. Julius Neumueller, Philadelphia, Pennsylvania; Dr. Henry Hofstetter, Columbus, Ohio; Dr. John D. Perry, Winston-Salem, North Carolina; and Dr. Arthur R. Neale, Patterson, New Jersey.

SECTION APPOINTMENTS

CONTACT LENS SECTION AND CONTACT LENS EXAMINING BOARD

In conformity with authority granted by the Executive Council at the Chicago 1947 annual meeting, Dr. Fisher has appointed a contact lens examining board to examine applicants for certificates in contact lens fitting. The men appointed are Dr. John C. Neill, chairman; Dr. Isadore Finkelstein, New York, New York; Dr. Meredith W. Morgan, Jr., Berkeley, California; Dr. Charles S. Bridgman, Columbus, Ohio; Dr. Arthur E. Hoare, Los Angeles, California, and Dr. Irving P. Filderman, Memphis, Tennessee.

The above group will also plan and organize the contact lens section meeting for the annual convention at Winston-Salem.

ANISEIKONIC SECTION

Dr. Julius Neumueller, Philadelphia, was appointed chairman of the aniseikonic section, which is in charge of planning the program for this section at the next annual meeting. Appointed to serve with Dr. Neumueller are Dr. Robert E. Bannon, New York, New York; Dr. Oscar L. McCulloch, Holyoke, Massachusetts; Dr. Rudolph T. Textor, Cranford, New Jersey, and Dr. Leo F. Madigan, Boston, Massachusetts.

ORTHOPTIC SECTION

Dr. Daniel Woolf, New York, New York, will be in charge of the 1948 orthoptic section meeting. The following doctors will serve on the committee with Dr. Woolf: Dr. J. Donald Kratz, Souderton, Pennsylvania; Dr. A. E. Hoare, Los Angeles, California; Dr. Glenn H. Moore, Chicago, Illinois; Dr. Kenneth B. Stoddard, Berkeley, California; Dr. R. W. Tubesing, Richmond, Virginia, and Dr. M. N. Chodroff, New York, New York.

CHAPTER ACTIVITIES

Attention of many Academy chapters has been directed this winter toward reading disabilities in children. Last month we reported in detail on a University of Minnesota educator's discussion of the subject. Since this report, two additional chapters write that they have studied this problem.

CUYAHOGA ACADEMY

Dr. D. G. Hummel reports that more than 400 educators, optometrists and psychologists attended the reading conference sponsored by the Cuyahoga Academy. This conference was the first of its kind in the

Cleveland area, and met with definite approval among those concerned with reading retardation evidenced by today's school children. At the meeting, it was recommended that reading instruction be continued through junior high school. Speakers agreed that reading disabilities could be overcome through cooperation of teachers, visual specialists, psychologists, and, of course, parents.

SOUTHERN CALIFORNIA CHAPTER

Members of the Southern California chapter engaged a psychologist to speak on this problem at a recent meeting. Dr. (Ph.D.) S. S. Hawks, head of the psychology department, Scripps College, discussed "Reading Difficulties in Children" for chapter members.

Also at this meeting, Dr. Rupert Flower, Visalia, California, became a chapter member.

MARYLAND CHAPTER

Guest speaker of the Maryland Chapter winter meeting was Dr. (Ph.D.) Vernon Schidt. Dr. Schidt's subject was "Aptitude Testing."

CURRENT COMMENTS

Virginia Huck
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

HAVE YOU HAD YOUR EYES EXAMINED LATELY?

The Better Vision Institute's 1948 theme will be, "Have you had your eyes examined lately?" It was adopted at the first meeting this year of the Institute in New York City with the thought in mind of emphasizing more than ever the need for regular re-examination. A survey of the American public's attitude toward professional eye-care service is also planned for this year. A similar survey was undertaken in 1941, and it is planned to bring these 6-year-old statistics up-to-date.

AMERICAN OPTICAL COMPANY ENTERS CONTACT LENS FIELD

The American Optical Company is now operating a plastic contact lens manufacturing laboratory at 33 John R. Street, Detroit, Michigan.

Company officials report the laboratory is prepared to offer optometrists prompt and complete contact lens prescription service.

DATES SET FOR A. O. A. SAN FRANCISCO MEETING

The American Optometric Association's 51st annual Congress

will coincide with San Francisco's Centennial Celebration of the discovery of gold in California, thus assuring convention-goers of plenty of between-meeting entertainment, convention officials report.

The Congress will be held in the Palace Hotel, June 20-24, 1948. Professional exhibits representing the latest in optometric methods and equipment will be featured. Committees are now working on the educational program, business sessions and entertainment.

ESTIMATES ON THE COST OF BRITISH HEALTH SERVICE

As the British government continues to work on the final details necessary to put the new national health program into effect, the following interesting figures come to light:

In 1946, a total of 18,690,370 persons were entitled to medical benefits. This year all persons will be.

The estimated annual expenditure on the Health Service will be $760 million. This figure includes hospital and specialist services, general practitioner services (and dental, pharmaceutical and supplementary optical services), local health authority services, and administrative expenses. The additional tax burden (net) is estimated at $475 million, an increase of about $47 for a family of four.

NEW PROTECTION GLASS BY UNIVIS

A common problem in industrial plants is that workers do not wear their safety goggles. A new-type goggle that is light, and cosmetically attractive, as well as protective, is announced by the Univis Lens Company. In appearance, the goggles look like regular, gold- or steel-framed glasses. The lenses are plastic, however, rather than glass, and light-weight side shields can be attached for additional protection.

Called "Safe-T-vis," these lenses average 3.2 mm. in thickness, plus or minus.

LEGION AWARD FOR TITMUS

In recognition of its willingness to employ handicapped veterans, Titmus Optical Company, Petersburg, Virginia, has been awarded an American Legion citation. The award is the only one of its kind made in Virginia, and only 25 similar awards were made throughout the United States.

E. Hutson Titmus, Jr., son of the founder and president of Titmus Optical Company, received the award from John A. Blakemore, Virginia American Legion State Commander. More than a score of handicapped persons are now working at Titmus plants, according to company officials.

MARKS HONORED AT N.I.C.O. COMMENCEMENT

On February 9, 106 students of Northern Illinois College of Optometry received their O.D. degree. Exercises were held for the first time in the school's new auditorium. Also present at commencement was Dr. Roy Marks, vice president, Univis Lens Company, who was awarded the honorary degree of Doctor of Ocular Science.

Dr. Carl F. Shepard, Director, Research Department, N.I.C.O., made the convocation statement, and the commencement speaker was Dr. Harry Helson of Bryn Mawr College.

AMERICAN OPTICAL COMPANY BOOKLETS

Booklets describing the development and principle of the Tillyer lenses are now available from the American Optical Company. Company officials announce they have prepared the brochures specifically for the ophthalmic professions, and will mail them to professional men upon request. Call AO zone headquarters or write directly to Southbridge, Massachusetts.

ABSTRACTS

A department in which will appear abstracts of the literature of optometry, ophthalmology and applied optics. These will be classified according to the following list although contributions to all sections will not necessarily appear in each issue.

1. Ocular Refraction.
2. Physiological Optics and Color Vision.
3. Ocular Muscles.
4. Orthoptics and Reading.
5. Anatomy, Histology and Embryology.
6. Ocular and General Pathology.
7. Ophthalmic Lenses and Material.
8. Instruments.
9. Hygiene and Illumination.
10. Applied and Physical Optics.
11. Education, Sociology and Economics.
12. Miscellaneous.

2. PHYSIOLOGICAL OPTICS AND COLOR VISION

THE VISUAL PERCEPTION OF FINE DETAIL. H. Hartridge. Transactions of the Royal Society. (London). 1947. 232. 519-671.

Monochromatic patches of light of different wavelength behave differently as the luminance of size or the patch is decreased. At one stage vision becomes dichromatic (reduced vision). Yellow and blue become white; all the other monochromatic stimuli appear red or blue-green or can be matched by mixtures of 650 mμ and 460 mμ as can also the yellow and the blue which appear white. The two hues remaining at this stage are comparable to those obtained with larger stimuli having wavelengths 650 mμ and 480 mμ. These monochromatic stimuli undergo no change in hue as the size of the patch is reduced. At a still smaller size

red and blue-green also become transformed to white and vision is thus reduced to a "colorless" stage.

To investigate these effects in detail, cardboard targets of various patterns, chromaticities, and luminances were mounted at the end of a long room and illuminated by daylight, and observed at different distances (0 to 37 m.) to vary the visual angle.

Yellow squares (Munsell 10.0 Y/8/6/) mounted on a black background lose chromaticness when the visual angle is reduced to 1.148 minutes of arc; i.e. when the illumination is 3000 f.c. and the artificial pupil provided by a Stubbs gauge has a diameter of 1.5 mm. Each tenfold reduction in illumination down to 1 f.c. with Ilford fitters requires approximately a two-fold increase in size of the yellow square to reach the critical point.

Switching fixation to a point to one side of the test object causes the image to fall at various degrees of eccentricity from the center of the fovea up to 26 minutes, but no degree of eccentricity was found at which the loss of chromaticness fails to occur.

Substitution of a long, narrow rectangle (6 x 24 mm.) for a square of the same area does not affect the result appreciably; the one loses chromaticness at 26.7 m. and the other at 24.9 m.

A second yellow object near the first but separated by an interval forestalls the loss of chromaticness as the distance of observation increases. This effect decreases as the separation of the second object from the first increases.

The effect of increasing area and of juxtaposing a second stimulus of the same color, calls for the postulation of neurological mechanisms which permit the stimulation of one part of the retina to facilitate the response in an adjacent part.

The same general results were obtained with red (Munsell 5.0 R/5/12), blue-green (Munsell 2.5 B/5/6), and blue (Munsell 7.5 PB/5/14) except that the size at which blue-green loses chromaticness is not affected by changing intensity (4—3000 f.c.) and the size at which chromaticness is lost is much smaller for red and blue-green than for yellow and blue.

The effect of varying the luminance of the background is shown in the following table.

Distance in meter at which 6 mm. colored squares lose chromaticness.

Background	*Red*	*Yellow*	*Blue-Green*	*Blue*
Black	50	10.6	35	28
White	19	10.0	23	7.5

When the colored objects are placed on a background of a complementary color, they lose chromaticness at a shorter distance of observation than when on a white or black background. This is not due to the aberrations of the eye that permit an encroachment of the background on the retinal image of the object. This is shown by varying pupil size while the retinal illumination is kept constant. Furthermore the object can be separated from its complementary background by a black strip without abolishing the effect. A neurological "antichromatic mechanism" involving interaction between retinocortical pathways is postulated to account for this.

Furthermore in the case of white points and lines on a black background or vice versa or in the case of a border separating black and white areas, chromatic aberration, instead of compensating color effects, produces blue and yellow fringes which in turn are neutralized by the antichromatic mechanism.

If a gray object on a yellow background is large enough, it acquires a yellowish appearance (simultaneous color contrast), but this is reduced again to gray if the size is decreased. This fact is presented as evidence that the antichromatic mechanism lies behind the contrast mechanism (p. 581) but later (p. 583) changes in brightness associated with loss of chromaticness are interpreted to mean that all these effects are allied to each other and perhaps different aspects of the same mechanism.

The hypothesis that the antichromatic mechanism lies in front of the binocular fusion center is proved by showing that a stimulus in one eye does not destroy the chromaticness of a complementary stimulus falling on a disparate area of the opposite retina.

The loss of chromaticness by reducing the size of an object and by juxtaposing complementary colors operates to considerable advantage in reducing the colored fringes produced by chromatic aberration in the eye and chromatic optical systems used as adjuncts to the eye. In the case of black and white objects, the fringes are complementary and narrow. Reducing the illumination helps. The author has used new findings in recalculating the effects of chromatic aberrations of the normal eye at borders. The data presented are usable in the design of optical instruments. Improved methods of investigating axial chromatic aberration are described.

New methods of investigating chromatic dispersion of the eye are also described. Correction for it by means of prisms provides no increase in acuity.

In Part VI an explanation of the transition from full color vision

through reduced vision of colorless vision with small objects is explained by a three component theory involving three photoreceptors responding one primarily to long, a second to medium, and a third to short waves of light, and three corresponding cranial centers. The receptor responding to the middle region of the spectrum is connected to all three cranial centers in colorless vision, and the responses of the other two photoreceptors are prevented from reaching their cranial centers. In reduced vision the short wave receptors have their responses intercepted, and the medium wave photoreceptors are connected to the blue and green cranial centers. In full color vision each type of photoreceptor is connected to its own cranial center.

A small white object was observed under different levels of illumination. As the intensity increased from zero the white was first seen white, then brownish, and finally again as white. This is interpreted to mean that the long-wave receptor makes its connection with the long-wave cranial center at the same time that the medium-wave receptor loses its connection with the long-wave cranial center. At a higher level the medium-wave receptor loses its connection with the short-wave cranial center and finally at a higher level, the short-wave receptor makes its connection with the short-wave cranial center.

In using a black Landolt ring on white, red, green, and blue backgrounds, the maximum acuity was found to be approximately the same for all colors (1.89, 1.63, 1.86, and 1.72). From this experiment it is concluded that the fineness of the retinal mosaic determines the acuity and that the three types of receptors are located in clusters. Additional evidence, however, is brought forward for the cluster hypothesis. By using fixation targets consisting of 3 mm. red, green, and blue disks on a black background at 3 to 4 m., relative positions were found for which fixation could be switched from one to the other without eye movement. By using a special arrangement called a micro-stimulator, two monochromatic point sources could be presented simultaneously and the position of one could be shifted with respect to the other. The author took advantage of a small scotoma for red light near the center of the fovea of the left eye and located its position with a red point while the eye was fixating various colored points. The fixation points fall on lines forming a triangle with 660 mμ, 460 mμ, and 420 mμ at the corners. The fixation point for white coincides with that for 540 mμ.

With the eye fixing a green disk 3 mm. in diameter at 3 to 4 m., the area surrounding was explored with a 3 mm. gray disk by placing it in contact with the green disk but in the eight cardinal directions from

it. Gray, pink, and pale blue-green colors were obtained at the various positions. These colors are assumed to indicate that the gray disk falls on blue, green, and red clusters of receptors. The position corresponding to the red fixation point yielded pink and that corresponding to the blue fixation point yielded gray.

The retinal direction effects and retinal astigmatism are also used as evidence for the cluster hypothesis.

In Part XI the Wundt-Granit polychromatic theory is considered. By using the micro-stimulator, the region surrounding a fixation point was explored with a white and also with monochromatic points of various wavelengths. Each stimulus yielded different colors at different points, and occasionally small scotoma for red, orange, and yellow sources were found. These data are interpreted as evidence for the existence of red, orange, green, blue-green, and blue receptors. Other types of evidence justify the addition of yellow, yellow-green, indigo blue, and violet to the list.

A method is presented for determining the response curve for the yellow receptors which is based on the effect on a yellow stimulus of small area produced by a nearby monochromatic stimulus. Affecting stimuli close in color to yellow facilitate the perception of yellow in the small patch, but this effect decreases as the color of the affecting stimulus changes in either direction from yellow.

A multireceptor theory of color vision, whether the receptors of a given type are grouped in clusters or freely intermingled with other types, presents a problem for the perception of a uniform white surface. It was demonstrated, however, that a pattern of red, green, and blue disks (1.374 min. in diameter and separated 6.87 min. from each other) on a black background with no two neighboring disks having the same color neutralize each other so that all appear gray.

A uniform red surface presents a different type of problem in that leaving some of the receptors unstimulated should leave small scotoma of irregular shapes and even punctate patterns. It is proposed that these scotoma are filled in the same manner as the blind spot produced by the hole in the retina at the head of the optic nerve.

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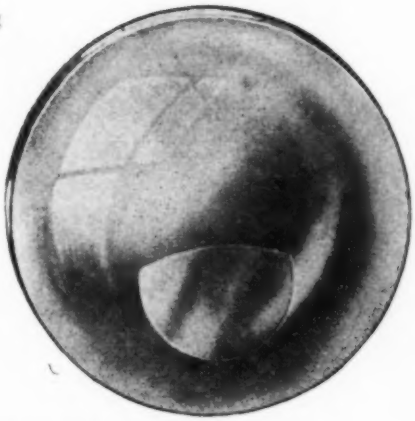

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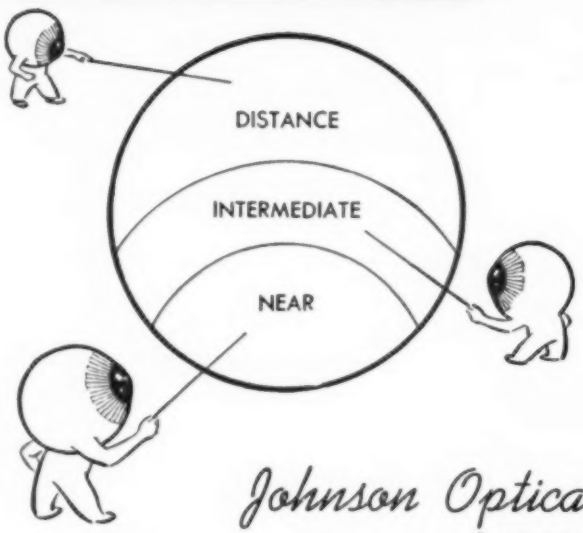

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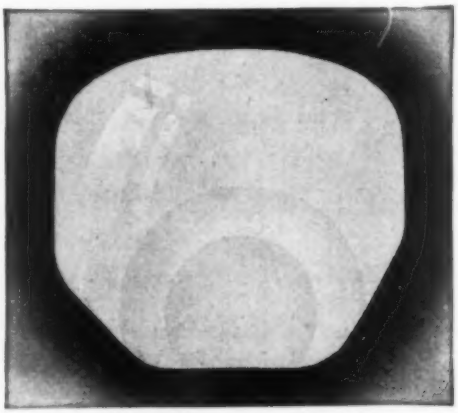

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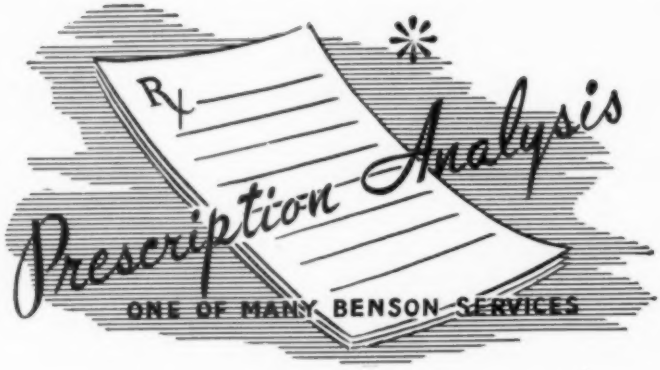

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